



INDIAN AGRICULTURAL
RESEARCH INSTITUTE, NEW DELHI.



INSECT PESTS OF BURMA

BY

C. C. GHOSH, B.A., F.R.E.S.,

ENTOMOLOGIST, BURMA,

AGRICULTURAL COLLEGE AND RESEARCH INSTITUTE, MANDALAY

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INSECT PESTS OF BURMA.

Introductory.

The common people of Burma possess hardly any accurate knowledge about insects. All insects go by the common name *po* to which occasionally the plant on which an insect happens to occur may be added or at best the name may indicate how the insect feeds. Necessarily there is a good deal of confusion about descriptions of insect pests. Very often the same name is applied to different pests while again the same insect is called by different names in different parts of even the same district. Therefore no reliance can be placed on vernacular or local names. The people are also ignorant of the life, development and habits of insects, with the result that superstitious, fantastic and incorrect beliefs are entertained. The origin of insect pests is ascribed to absurd causes and equally absurd methods of control are not infrequently resorted to in the anxiety to save crops from damage, such as giving offerings at the pagoda, uttering incantations, putting up a charm, burying a bone or a portion of a woman's under garment and so on. Frequently the appearance of a pest is supposed to be of supernatural origin and therefore considered hardly amenable to human control and no attempts are made at control. Disorders in plants not due to the activity of any insect but to fungal diseases or other causes are also generally ascribed to *po*. This leads to further confusion and inaction.

The best remedy for this unfortunate state of affairs is to remove the ignorance and enlighten the people about the life and habits of insects. When the people will realise that insects are neither showered down like rain nor created out of nothing by the anger of a *nat* (spirit) but are born of parents like all other animals, and are endowed with power under favourable condition of very rapid multiplication and increase which however can be checked by human efforts, they will of their own accord and guided by the instinct of self interest take steps to see that insects occurring on crops are removed in the same way as cattle eating a crop require to be driven away.

An attempt has been made in this publication to acquaint general readers with elementary facts about insect life and with the common insect pests which have been observed to occur in Burma on field and garden crops, common garden plants, fruit trees and common articles in the store, that is, with those pests which are met with by the people in their every day life and affect them injuriously. Simple practicable

methods where possible have been suggested for preventing and overcoming damage. Vernacular and local names as far as ascertainable have been referred to the pests dealt with in the book. A few non-entomological animals, such as crabs, ticks, mites and rats have been included as they too are common pests and frequently advice is asked about them.

As the book is meant primarily for general readers technical descriptions have been reduced to the minimum but the scientific basis has been maintained so that it may be improved upon in future. Reliance has been placed more on illustrations of the insects concerned than on vernacular or local names or elaborate descriptions. The illustrations will enable identification of the actual pests.

The writer was in charge of the entomological work of the Burma Agricultural Department from 1921 to 1936. From 1909 to 1918 Mr. K. D. Shroff, Assistant Entomologist was in charge and some of his work has been incorporated in this publication.

The coloured illustrations of most of the insects dealt with add greatly to the value of the book. Almost all of them were got prepared in the Agricultural Research Institute, Pusa (all except seven by the writer while working as Assistant to the Imperial Entomologist) and appeared originally in Indian Insect Life, Entomological Memoirs of the Imperial Department of Agriculture, Pusa, Proceedings of the Second to Fifth Entomological Meetings held at Pusa and in *Fasaler Poka* (a book in Bengali on insect pests by the writer). The Secretary, Imperial Council of Agricultural Research, New Delhi has very kindly made the blocks available for printing the illustrations used in this publication. Unfortunately a few blocks were missing and half-tone blocks were made from three-colour prints. The other illustrations, where not acknowledged, are original and prepared with the help of W. Ta Yin and Maung Sein Nyun, artists at the Agricultural College and Mr. B. N. Ghosh, amateur artist.

The vernacular and local names are compiled from information partly gathered by the Entomologist and his staff and partly supplied by Deputy Commissioners, Subdivisional and Township Officers, Superintendents of Land Records and District Agricultural Officers whose help is thankfully acknowledged. Unless common, the places where the local names are used have been added and also the dialect within brackets.

An important point about illustrations.

An important point to be remembered while referring to the illustrations, both coloured and uncoloured, is that the illustrations are always drawn considerably more enlarged than the insects. Otherwise

the details of their structure cannot be shown. Readers should bear this in mind and invariably refer to, and form an idea of, the actual size of the insects, indicated alongside each figure by either an outline drawing or a hairline which indicates the length or a + which indicates the length and expansion of wings. In the case of only a few large insects the figures show actual size and no sizes are indicated separately. When any illustration is referred to in the text by the word "figure" or "fig." the necessary number should be looked for in the plate illustrating the life-history of the insect concerned. Text-figures are numbered separately and serially from beginning to end of the book.

PART I.

GENERAL FACTS ABOUT INSECT LIFE AND PESTS.

Insects are living animals generally of small and most of them of very small size. Owing to the small size and unobtrusive habits they are overlooked and do not attract our attention as much as large animals do. But they eat food and breed, that is produce young ones, like all other living animals. They however exhibit certain peculiarities in the manner of taking food, in the manner of birth and growth and in habits.

As regards manner of taking food some cut, bite, chew and swallow solid food and are provided with biting mouth parts. Others are provided with piercing and sucking mouth parts and can take only plant juice or blood of other animals. Therefore as regards manner of eating, insects are divisible into two classes, *viz.*, biting and sucking. Ants, cockroaches and caterpillars bite, chew and swallow food. Bed bugs and mosquitoes pierce our skin and suck blood.

The difference and diversity in the manner of birth and growth will be evident if we consider the method of birth and growth of a few large animals with which all are familiar. Cats and dogs are born as helpless kittens and pups which have to be fed and taken care of by the mother for some time. Gradually their eyes open, they grow and are able to move about, to take other food than the mother's milk and finally to take care of themselves independently of the mother. Calves are able to run about only a few hours after their birth. Ducks and fowls produce eggs and not living young ones. Eggs have to be looked after and kept warm so that the young ones may develop in them and when developed they come out by breaking open the egg shells. Newly hatched young birds have hardly any feathers. These grow gradually and it is only after the growth of the feathers that the young ones resemble the parents in appearance. Kittens and pups fully resemble their parents at birth and only grow in size with age. Calves have to undergo a little change in developing horns before they resemble their parents fully. Ducks and fowls are born as eggs and the young birds have to undergo a further change in developing feathers before they resemble the parents. This change of form is called metamorphosis. The young ones of all these animals again have to grow to a certain age before being able to breed and produce young ones. When they are able to do so they are considered to have attained the adult state. It is in the young state that the necessary metamorphosis takes place.

Insects form the largest numerical class among living animals and different groups of them show a good deal of diversity in the manner of birth and growth.

Some are born living like kittens and pups, resemble the mother in form and appearance and have only to grow in size to attain the adult

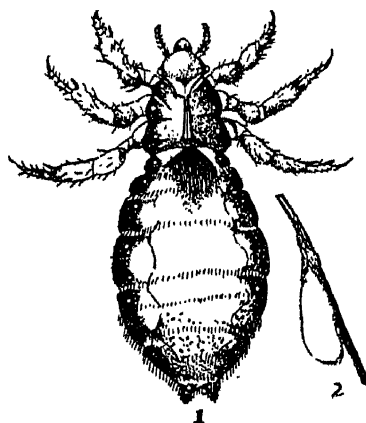
state without any metamorphosis. The plant louse (*pya*) known as aphid falls under this group.

The largest majority of insects are born in the form of eggs. Out of them (a) in some the young ones, like the young ducks and fowls, although not differing from the parents completely in form, have to undergo a partial metamorphosis before attaining the adult state. Cockroaches and crickets (*payit*) are typical examples of insects with such partial or incomplete metamorphosis and the young state in such cases is known as the nymph; (b) in others metamorphosis has gone a step further and has become so complete that the young state is passed in forms wholly different from that in the adult state. Butterflies, moths, beetles, bees, wasps, flies, mosquitoes, etc., are examples of insects with such complete metamorphosis. A brief description of the life of a few common insects will help in making these points clear and will also explain salient points in the life and habits of insects.

THE HEAD LOUSE.

(*Pediculus capitis* De Geer.)

VERNACULAR AND LOCAL NAMES.—*Than*; *Tho* (Leiktho—*Gebba-Karen*.)



Text Fig. 1.

1, HEAD LOUSE AND 2 ITS EGG ATTACHED TO A HAIR. X15.

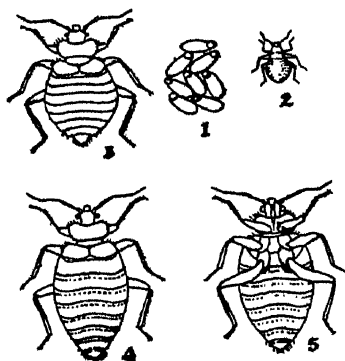
All are familiar with the head louse and its egg which is gummed to the hair. The young louse when hatching out of the egg is very small in size but resembles the adult louse in form and appearance and has only to grow in size with age to attain the adult state. Both the young and the adult lice feed by piercing the skin with their beak and sucking blood.

It is an example of an insect with hardly any or incomplete metamorphosis. It passes its whole life in situations where wings are of no use. It never develops any wings.



Aphis or Plant louse
(Mustard aphis)

BED BUG.

(Cimex lectularis Linn. and *C. rotundatus* Sign.)VERNACULAR AND LOCAL NAMES.—*Gya bo* ; *We* (Leiktho—*Gebba-Karen*.)

Text Fig. 2.

LIFE-HISTORY OF BED BUG.

1. EGGS, 2. YOUNG AND 3—5. GROWN BUGS, 5. TURNED ON ITS BACK. X3.

All know bed bugs which pierce the skin with their beak and suck our blood. Their flat body enables them to creep into and hide in cracks and small openings in chairs, bedsteads, mats and mat and wooden walls and floors of houses. Like the head louse the bed bug also has no necessity for and never develops wings.

Tiny jug-shaped white eggs are gummed in crevices in bedsteads, chairs, beds, walls, etc. The young ones hatching out of the eggs, resemble adult bugs in form and appearance and feed in the same way and have only to grow in size with age and attain the adult state in the course of about two months. Adult bugs lay eggs and the life-history is repeated.

The bed bug is an example of an insect with incomplete metamorphosis.

PLANT LOUSE (APHIS).

VERNACULAR AND LOCAL NAME.—*Pya*.

Plate 1.

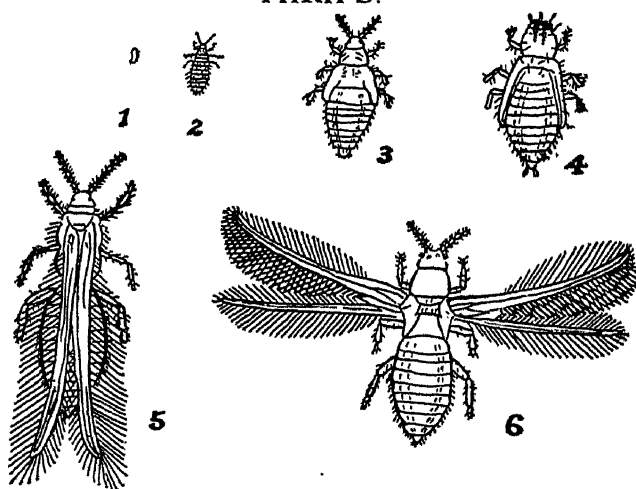
Cultivators and gardeners are familiar with this insect which occurs in large numbers frequently covering leaves, shoots and fruits of infested plants (Fig. 1). It is very small and does not bite or eat any part of the plant. It has a small beak (Fig. 5) which it thrusts into the plant tissue and sucks juice in the same way as bed bugs and lice suck human blood. Therefore it is called plant-louse. It has another peculiarity. It is born as a living young in the same way as a calf is born (Fig. 2). The aphids which are commonly met with are all females. The young ones are exactly like the mothers (Fig. 3) only smaller in size. They soon grow and are capable of giving birth

to young ones when only about five or six days old and then go on feeding and producing young ones day and night. Each may give birth to about a hundred to a hundred and fifty daughters. Therefore when a single female happens to come and sit on a leaf and breed, very soon there is a large family of daughters, grand-daughters, great-grand-daughters and so on and all breeding. If a colony on a leaf is examined aphids in all stages of growth will be found. The number thus increases very rapidly and the family soon covers practically the entire plants. With increase and crowdedness some develop wings and fly to other plants. Figure 4 shows one which has developed wings partly and figure 5 one with wings fully developed. It will thus appear how whole fields and whole areas may soon become covered with aphids.

As millions and millions go on sucking juice day and night the infested plants can hardly stand such loss, become stunted and may dry up. This insect though small is therefore a very serious pest.

It is an insect with incomplete metamorphosis.

THRIPS.



Text Fig. 3.

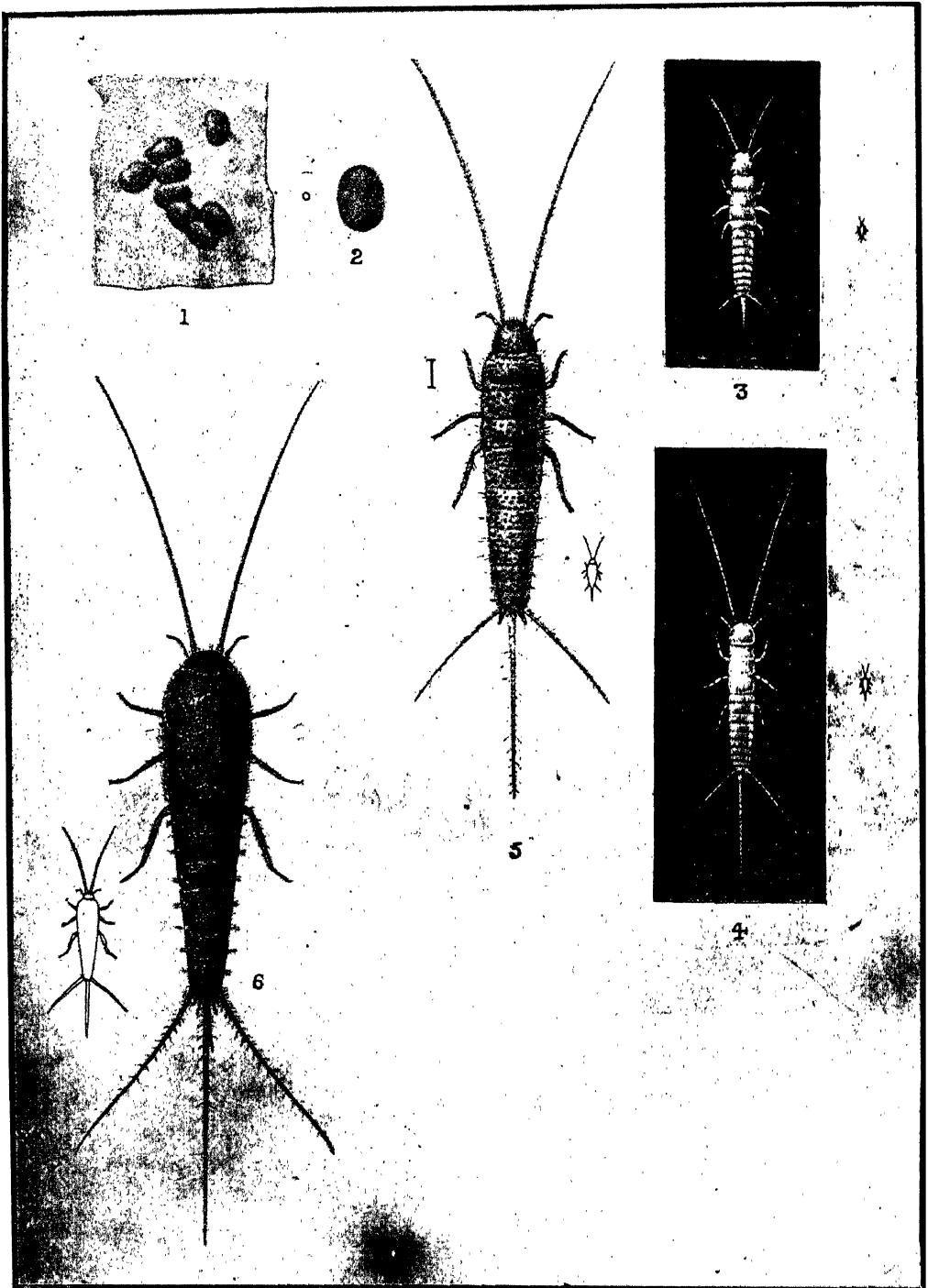
LIFE-HISTORY OF THRIPS.

1. EGG, 2—4. NYMPHS, 5. ADULT THRIPS, 6. ADULT WITH WINGS SPREAD, X10.

Thrips are minute insects less than about one-sixth inch in size and are of various colours such as red, yellow, black and so on. They feed by piercing and lacerating the tissue of leaves. They commonly occur in flowers and some are bad pests infesting whole fields. As millions of them occur together they are capable of considerable damage in a short time.

Adult thrips can be easily distinguished from all other insects by their slender elongated body and the fringe on the edge of their wings. Eggs are laid on the leaves. The young ones feed in the same manner

Plate 2.



SILVER FISH (*Lepisma Sp.*)

as the adults and gradually grow and develop wings with age and attain the adult state when the wings are fully developed. Thrips are insects with incomplete metamorphosis.

SILVER FISH.

(*Lepisma* sp.)

Plate 2.

This insect is commonly met with in the house nibbling the surfaces or biting off portions of paper, books and pictures and spoiling them. Books, etc., which are not handled or disturbed and aired for long periods suffer in this manner. Clothing stiffened with sizing may also suffer. Flattened disc-like eggs (Figs. 1 and 2) are deposited among debris, papers, etc., and hatch in about one to two weeks. The young ones (Figs. 3, 4 and 5) are like the adult ones in appearance but are much smaller in size and at first paler in colour. They take several months to grow to the adult state (Fig. 6) and live for several months more. The young ones as well as the adults feed in the same way. This insect never develops wings and is the example of wingless or apterous insects with incomplete metamorphosis.

THE LARGE BROWN CRICKET.

(*Brachytrypes portentosus*, Licht.)

Plate 3.

VERNACULAR AND LOCAL NAMES.—*Gridaw-saw* (Leiktho—Gebba-Karen); *Parite* (Akyab-Arakanese): *Payit* or *Payit-gyi*.



Text Fig. 4.

THE LARGE BROWN CRICKET IN ITS NATURAL BURROW.

Most people are familiar with this insect. It is sold for use as food in markets in a fried condition, being then known as *payit-kyaw*.

The life history of this large cricket is interesting. It lives in holes underground and throws up a heap of earth from the mouth of the

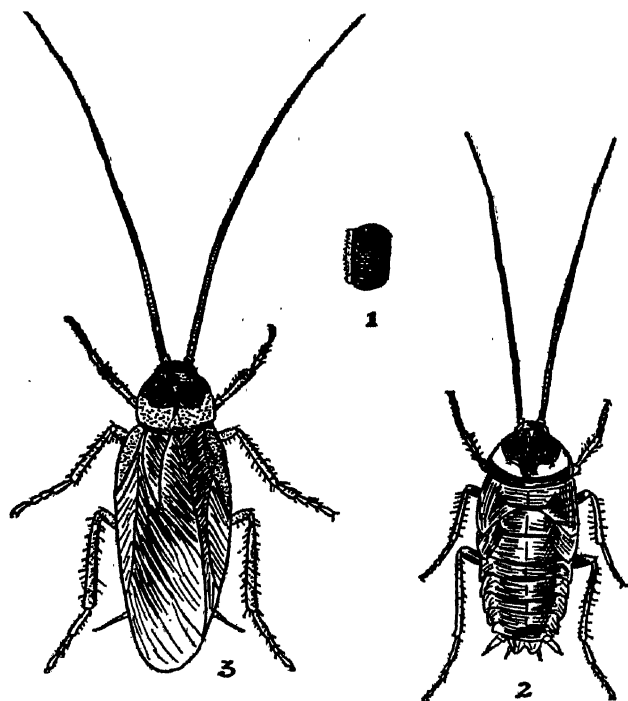
hole (Text Figure 4). In the rainy season a very shrill sound is produced by the male and towards the latter part of the rains this sound becomes very common. This is the mating season and the females lay eggs (Figs. 1 and 2) inside the under-ground burrows about September and October. The young crickets (Fig. 3) hatch out of these eggs in the course of about a month. They are small and have no wings. They too live in under-ground burrows which they themselves dig throwing up small heaps of earth. They grow gradually casting off the skin at intervals and wings begin to appear (Figs. 4 to 6). The crickets attain the adult state when the wings are fully grown between May and July (Fig. 7). Mating takes place and eggs are laid as described above and the adults die off. This insect has incomplete metamorphosis.

The crickets are mainly vegetable feeders and nocturnal in habit and cut across the stems of small plants which are carried into the burrows.

COMMON COCKROACH.

(*Periplaneta americana* L.)

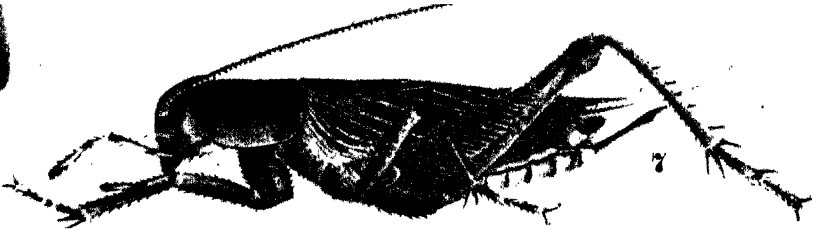
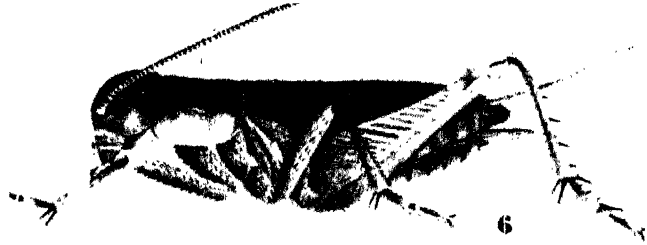
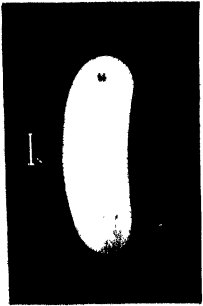
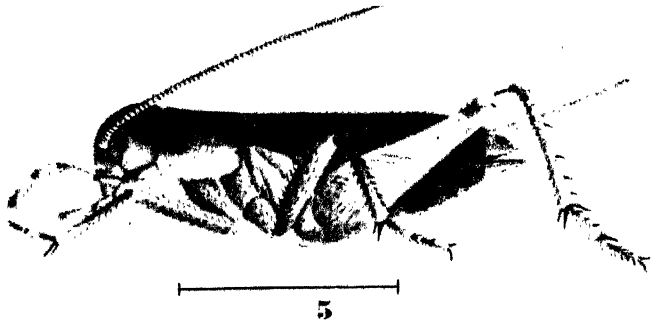
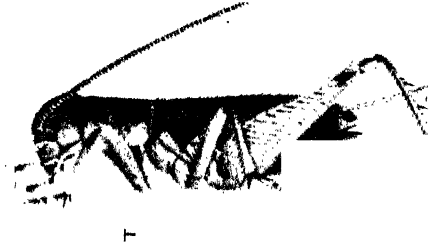
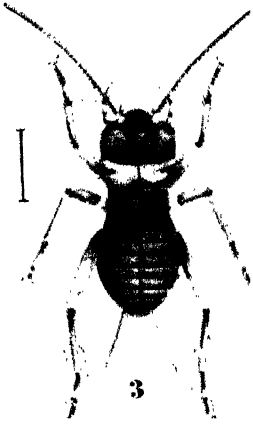
VERNACULAR AND LOCAL NAMES.—*Po-hat* ; *Khaw-bi* (Leikthe *Gebba-Karen*).



Text Fig. 5.

THE COMMON COCKROACH.

1. EGG CAPSULE, 2. ABOUT HALF GROWN NYMPH, 3. ADULT COCKROACH.



The Large Brown Cricket
(*Brachytrypes portentosus*)



Lemon Butterfly
(*Papilio demoleus*)

The cockroach is a familiar insect in houses, godowns, unused boxes and in fact in almost all unused dark corners. It usually lives gregariously, seldom comes out during the day time and moves about and flies at night. It feeds on various kinds of food kept in the house such as rice, vegetables, meat, fish, cakes and sweets and also on dead insects, on dead cockroaches, etc., and in fact on whatever may be available.

Eggs of cockroaches are not deposited singly. A number of eggs 14 to 18, usually 16, are contained in a capsule. Frequently cockroaches are found carrying the egg-capsule about partly protruded out of the hind end of the body. The capsule when deposited is gummed to a place and hidden. When the eggs mature the young cockroaches issue out of the capsule and in form and appearance of the body they resemble the mother but have no wings. With age and growth wings begin to develop as folds of the skin on the two sides. The figures show a young one with partly developed wings. The nymph during growth casts skins about 7 or 8 times and attains the adult state when the wings are fully developed. The time taken for this development extends to about one to two years. The cockroach therefore is a slow-growing and long lived insect with partial or incomplete metamorphosis.

THE LEMON BUTTERFLY.

(*Papilio demoleus* L.)

VERNACULAR AND LOCAL NAMES.—*Bauk-hpat* (Minbu); *Hngel-chee-fo*, i.e., insect like bird's dropping (Thayetmyo).

Plate 4.

This common butterfly will be easily recognized from the illustration (Figs. 9 and 10). It is found flying over citrus plants and depositing small round eggs (Fig. 1) on tender leaves and shoots. The caterpillars which hatch from these eggs eat leaves and live openly on the upper surfaces of the leaves where from a distance they look like birds' droppings (Figs. 2 to 5). When they grow they turn green and then sit on green stems so as not to be easily distinguished (Fig. 6). The caterpillar has other means of protection against enemies. If its body is touched or pricked it thrusts out a pair of soft hornlike processes from behind its head (Fig. 3) at the same time emitting a strong pungent smell. When fullfed and fullgrown the caterpillar secures itself to a branch with a girdle (Fig. 7) and then transforms into chrysalis or pupa (Fig. 8) which may be green or brown in colour. The butterfly issues out of the chrysalis.

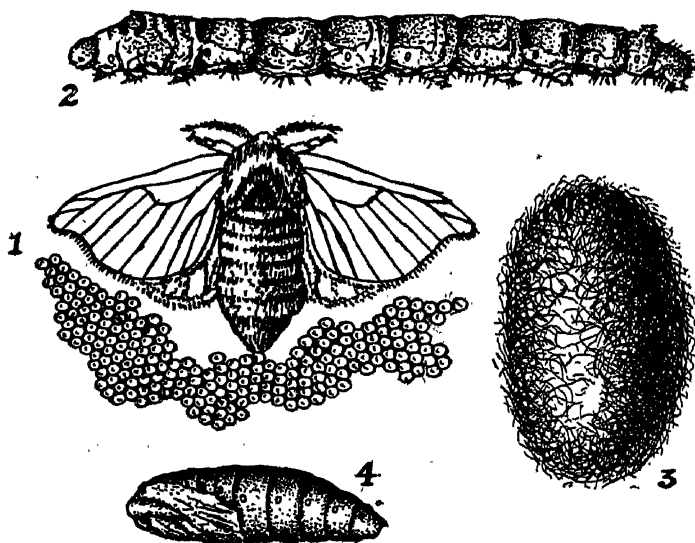
No food is taken by the pupa. Butterflies (Fig. 9) have a long slender proboscis which is usually held in a coiled position but is straightened and inserted inside flowers for sucking out nectar which forms their food.

The young state of the butterfly is thus passed first as egg (*oo*), then as caterpillar (*bauk-hpat*) and then as pupa or chrysalis (*Po-ton-lon*). This is an example of complete metamorphosis. The second or caterpillar state is known as the larva. Eggs hatch in about three days. The caterpillar or larva state lasts for about 15 days and the pupal state about seven days. Butterflies lay eggs the day or the day after they are born but may live for about ten days. The eggs hatch and there is another generation of butterflies and generations are thus repeated.

SILKWORM.

(*Bombyx mori*.)

VERNACULAR AND LOCAL NAMES—*Po* ; *Pogaung* ; *Napho* (Leikho—Gebba-Karen).



Text Fig. 6.

LIFE-HISTORY OF THE SILKWORM.

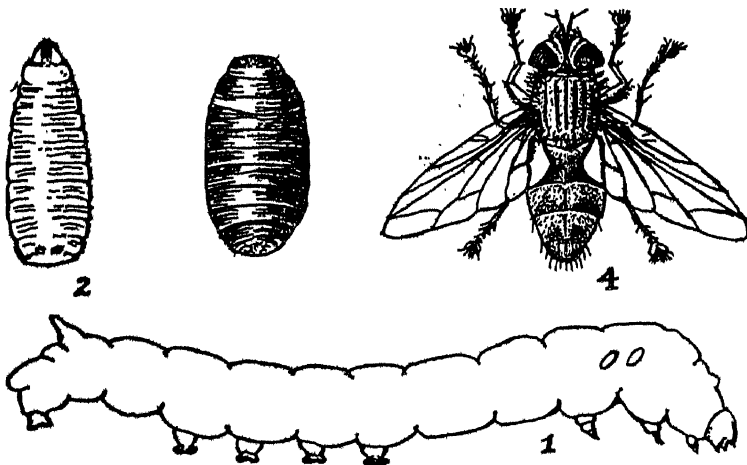
1. MOTH LAYING EGGS, 2. SILKWORM, 3. COCOON, 4. PUPA.

The silk thread with which silken *aingies* (coats), *longies* (cloth), *goung-boungs* (turban) and *powas* (scarf) are woven is obtained from the silkworm (*po-gaung*).

The silkmoths (*po-hpala*) lay eggs (*oo*) from which silkworms (*po-gaung*) hatch out as tiny worms in about seven days. The worms feed on mulberry (*posa*) leaves, grow and when full grown throw out silk thread from their mouth and spin cocoons (*po-ains*) round their own body in about three weeks. Inside the cocoon the worm changes into the sleeping pupa. The moth develops from this pupa and issues out of the cocoon by opening a hole at one end after about nine days. The moth lays eggs and the life of the silkworm is repeated successively in this manner. The silk thread is obtained by boiling the cocoons in hot water and unravelling the filaments from them.

The egg, the worm and the pupa are the young states of the moth which is the adult insect. The silkworm therefore is an example of insects with complete metamorphosis.

Silkworms are kept in houses and fed with care in order to have silk from them. A fly (Text Fig. 7) however causes the death of many silkworms by depositing eggs on their body. Maggots hatching out of these eggs bore into and eat the contents of the body of the silkworm which dies as a consequence usually after spinning its cocoon and sometimes after pupating. The parasitic fly maggot when fullgrown bites its way out of the body of the dead silkworm or pupa and also out of the cocoon and pupates usually on the ground and afterwards issues as a fly. All parasites work in this manner depositing eggs on or inside the body of the host by piercing it with the ovipositor. In the case of the useful silkworm the parasite is injurious. But parasites which occur on injurious insects are beneficial.



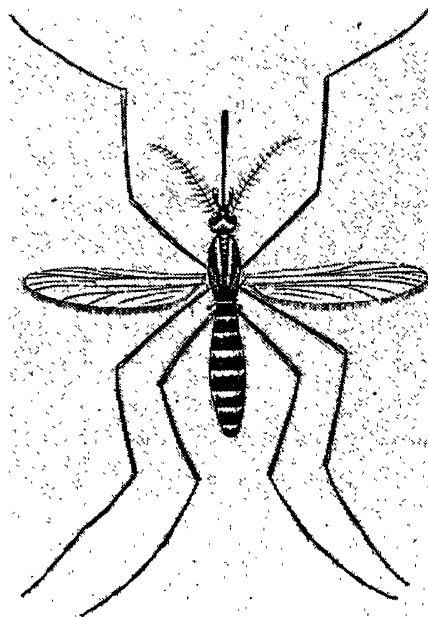
Text Fig. 7.

LIFE-HISTORY OF FLY (*Tricolyga Sorbillans*) PARASITIC ON SILKWORM.

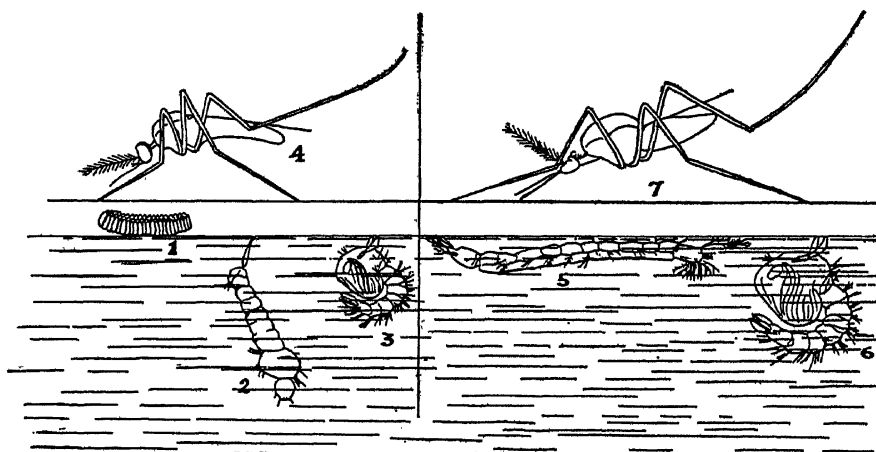
1. TWO EGGS OF THE FLY ON A SILKWORM, 2. MAGGOT, 3. PUPARIUM, 4. FLY. X5.

MOSQUITO.

VERNACULAR AND LOCAL NAMES.—*Chin* ; *Chin-gaung* ; *Hpo* (Leiktho—*Gebba-Karen*).



Text Fig. 8.
A COMMON HOUSE MOSQUITO.
(*Culex fatigans*.)



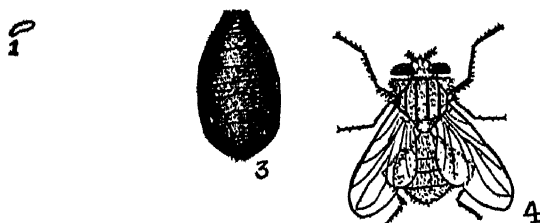
Text Fig. 9.
LIFE-HISTORY OF MOSQUITOES.
EGGS (1), WRIGGLER (2) AND PUPA (3) OF COMMON MOSQUITO (4). WRIGGLER (5) AND PUPA (6) OF MALARIA MOSQUITO (7). NOTE SITTING POSTURE OF (4) AND (7).

There is hardly any one who does not know the mosquito, how it comes flying, sits on the body, pierces the skin and sucks blood. Very few however know how the mosquito is born. There are many kinds of mosquito. Text Fig. 9 illustrates the life-history of the common and the malaria mosquitoes.

The early life of the mosquito is passed in water. Eggs of the common mosquito are glued together in the form of a tiny raft which floats on water. Those of the malaria mosquito are laid singly and sink in the water. Wrigglers hatch out of the eggs. Those of the common mosquito are commonly met with in water kept in pots for a few days. They hang their head downwards. The wrigglers of malaria mosquitoes float horizontally under the surface. The wrigglers feed on tiny bits of vegetable and animal matter present in the water and grow and when fullgrown change into pupa which too floats in water. The mosquito develops from this pupa and leaves the water in the winged form familiar to all. To develop from egg to the adult state the mosquito ordinarily takes only about ten days. The mosquito has complete metamorphosis. Common and malaria mosquitoes can ordinarily be distinguished by the mode of their sitting.

THE HOUSE FLY.

VERNACULAR AND LOCAL NAMES.—*Yin* ; *Hpo-ba* (Leiktho—*Gebba-Karen*).



Text Fig. 10.

LIFE-HISTORY OF COMMON HOUSE FLY.

1. EGG, 2. MAGGOT, 3. PUPARIUM, 4. FLY. X4.

There is hardly any other insect so common as the house-fly. But few people know how the fly is born.

The fly deposits tiny cigarshaped white eggs usually in cowdung. The worm-like maggots which hatch from these eggs feed on the dung and are frequently found in numbers in it as creamy white elongated

wriggling worms with one end tapering. On becoming fullgrown the maggots move down into the earth and contract their body into a seed-like puparium. Inside this puparium the fly develops and issues out by opening one end like a lid. Ordinarily a fly takes about one and a half to two weeks to develop into the adult state from the egg.

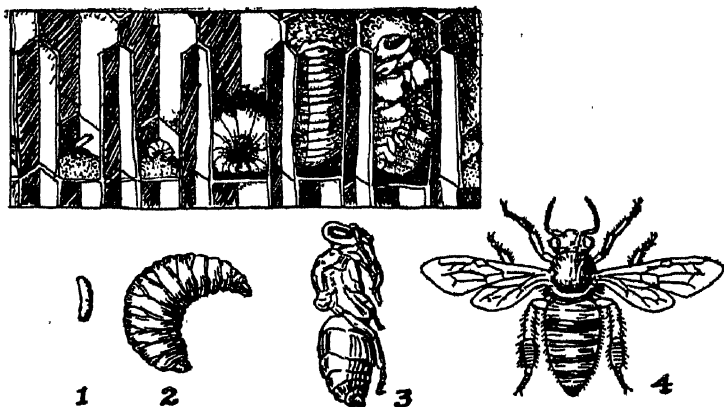
The house-fly has lapping mouth parts and laps up the substance on which it sits.

There are many kinds of flies with various food habits. Maggots are found in rubbish heaps, in cattle dung, in human excreta, in the wounds in the body of man and animals, in various kinds of fruits and also in mud and drains. Adult flies also differ in food habits, some having piercing mouth parts to pierce the skin of cattle and suck blood.

HONEY BEES.

(*Apis* spp.)

VERNACULAR AND LOCAL NAME.—*Pyah*.



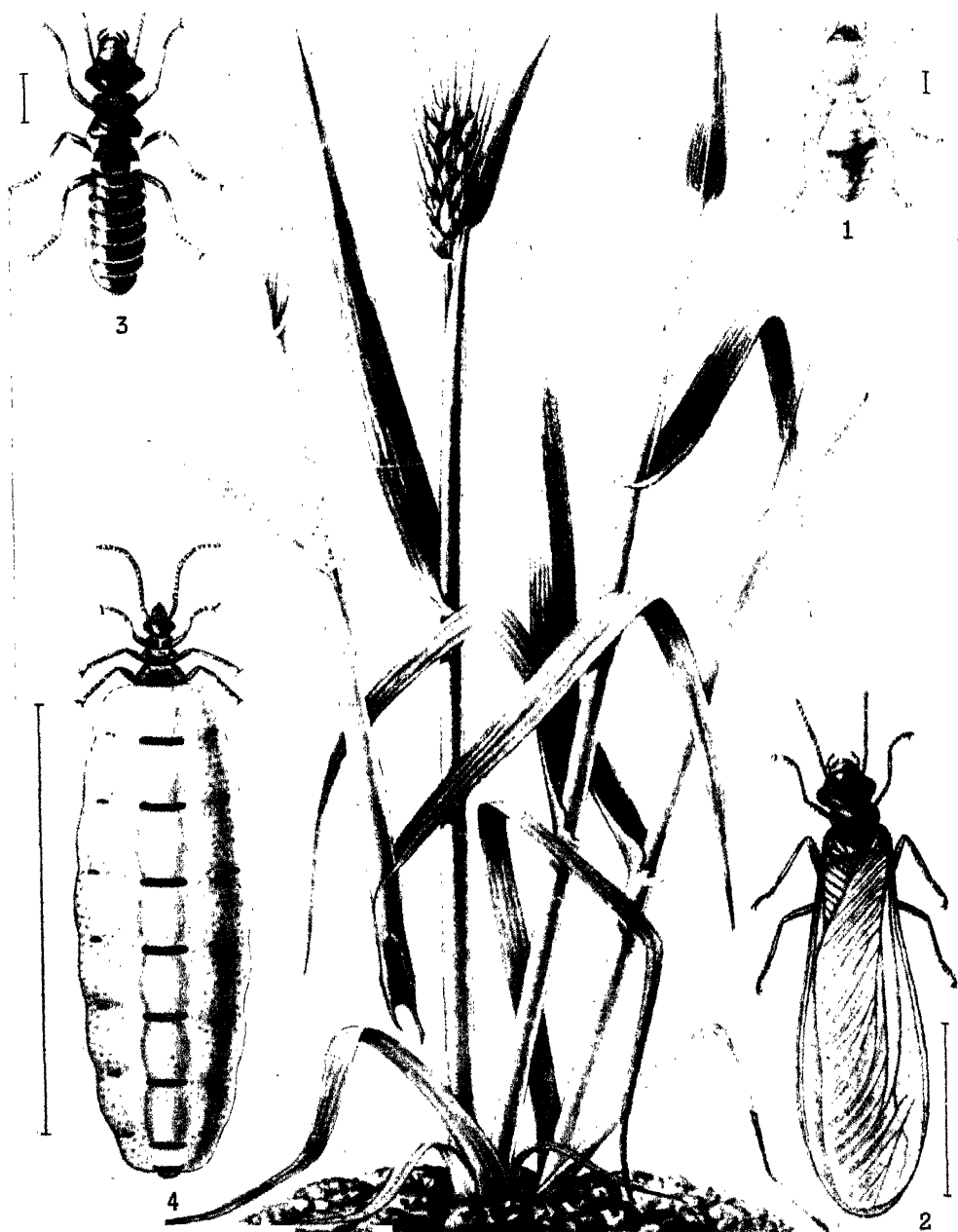
Text Fig. 11.

LIFE-HISTORY OF HONEY BEES.

1. EGG, 2. GRUB, 3. PUPA, 4. BEE.

EGG, GRUB AND PUPA IN CELLS OF COMB ABOVE. (AFTER GHOSH.)

Honey bees are social insects living together in colonies. They build combs where they live. The cells of the comb are used as cradles for rearing the brood, *i.e.*, young ones and also for storing honey which is gathered from flowers. Honey is ordinarily squeezed out of the combs in this country and beeswax is obtained by melting the combs.



Termites (White Ants)

The queen bee deposits an egg in the cell and when the young grub hatches out of the egg in about three days the bees feed it first with bee-milk secreted through their own mouth and then with bee-bread, a paste prepared with pollen of flowers and honey. When the grub grows in about six days the mouth of the cell is closed with wax by the bees and the grub changes into a pupa in the closed cell. The bee develops from the pupa in about 11 days, eats away the covering of the cell, comes out and takes its place among the bees in the colony. Bees are bred in this manner in the colony throughout the year in order to maintain the colony, as adult bees die in about three to six months. Honey bees are insects with complete metamorphosis.

In the bee colony there is one queen whose only function is to lay eggs and she lays several hundred eggs a day. The large body of bees usually found clustering on the combs or flying into and out of the hive are the workers who do all necessary work for the colony, *viz.*, building combs, collecting honey and pollen and rearing the brood. Only in particular seasons of the year are there some drones or male bees.

Some people in this province boil portions of combs with grubs and pupae in water which is used as a soup.

TERMITES (WHITE ANTS).

VERNACULAR AND LOCAL NAMES.—*Cha* ; *Po-oh* (Leiktho—*Gebba-Karen*); *Ku-khun* (Bhamo-Kachin).

Plate 5.

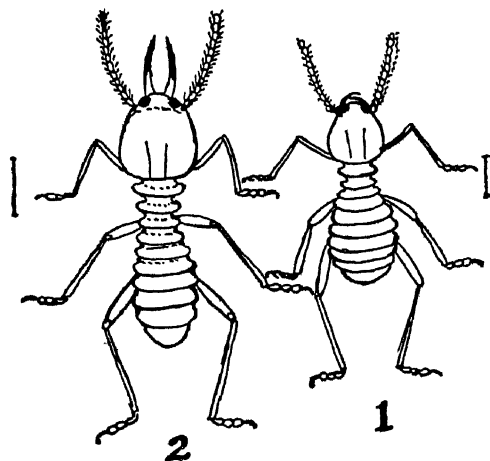
Termites, commonly known as white-ants, are known to everybody. They destroy wood, clothes, straw, books, papers, etc., and also growing crops.

Termites are social insects and live in large colonies usually underground and sometimes in mounds which are built out of the surface of the ground.

In the termite colony there is a peculiar division of work to be performed by different members as follows :—

(1) The majority of the members are workers (Fig. 1) which (a) collect food and in doing so bring about the loss and destruction from which man suffers, (b) build galleries and mounds with mud, (c) look after and rear eggs and young ones and feed all other members in the colony.

(2) There is another caste slightly bigger than workers and with much bigger jaws known as soldiers (Text Fig. 12). They emit when disturbed or handled a somewhat viscid fluid from their mouth which stains our hands.



Text Fig. 12.

WORKER (1) AND SOLDIER (2) OF TERMITES (INFESTING GROUNDNUT).

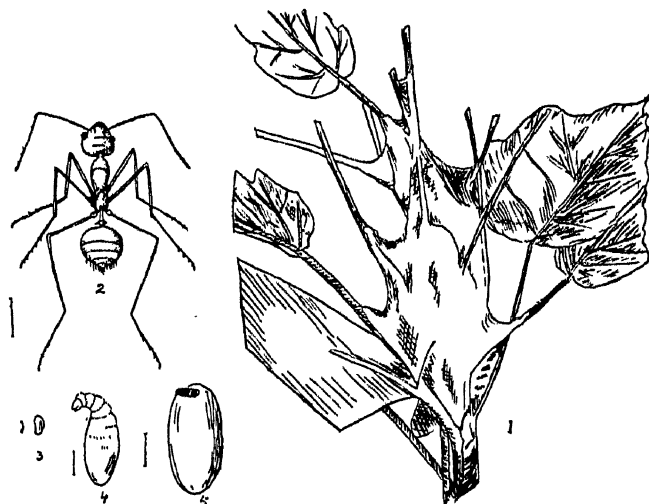
(3) There are also males and females which develop wings usually in the rainy season (Fig. 2) and fly out of the nest. Crows and other birds, frogs, lizards, etc., catch and eat many of them. After flying for a time they shed their wings (Fig. 3 has shed the wings) and when a male and a female meet they together burrow a hole in the ground and start a new colony. The eggs and the young ones which hatch from them are at first looked after and fed by the two parents with a liquid food discharged from their own mouth. When sufficient workers are thus born and reared they take up their own work and relieve the parents. The body of the mother now begins to swell and distend and ultimately she is a large soft mass as shown in Fig. 4 and she is spoken of as the queen. The king or male undergoes no change and is found by the side of the queen when a colony is opened. The only function of the queen is to lay a large number of eggs every day. An attempt at calculation has been made to show that she lays up to about eighty thousand eggs a day. It may be imagined how a termite colony increases in population and what damage the millions of workers thus born are capable of doing. Termites have incomplete metamorphosis.

Both the queen and the winged termites are used as food in some places in Burma.

RED TREE ANT.

(Oecophylla smaragdina, Fb.)

VERNACULAR AND LOCAL NAMES.—*Kha-gyin* ; *Doshe* (Ltho—*Gebba-Karen*).



Text Fig. 13.

RED TREE ANT (*Oecophylla smaragdina*).

1. LEAVES BOUND TOGETHER, 2. WORKER ANT, 3. EGG, 4. GRUB, 5. COCOON.
(1 AND 2 AFTER LEFROY.)

The red ants forming nests by binding together leaves with a silken papery substance is a common sight on many trees. These ants and their grubs are collected by some people and made into a sort of salad paste and eaten.

These ants, like honey bees and termites (white ants), are social insects and live together in colonies headed by queen ants whose function is to lay eggs from which all the ants in the colony are born. The ants ordinarily met with are workers which, like worker bees and worker termites, do all work for the colony. New colonies are established by queen ants which have wings and fly out of an old colony with males, mate and then establish themselves on other trees. At first the queen ant feeds the young ones born in the colony with a secretion from her own mouth. The work of rearing young ones is later on taken over by worker ants born in the new colony.

Ants are born as eggs from which grubs hatch. The grubs are looked after and fed and when fullgrown spin a cocoon round themselves and turn into pupæ inside the cocoons. Ants develop from the pupæ, bite their way out and take their place in the colony. Ants have complete metamorphosis.

These ants prey upon other insects and other animals and eat them.

THE RICE WEEVIL.

(Calandra oryzae Linn.)

VERNACULAR AND LOCAL NAMES.—*Asi-hpauk-fo*; *Gher*, *Hkoo-akha* (Toungoo-Karen); *Hsinthange* (Southern Shan States); *Mon-kauk-phan* (Southern Shan States-Shan); *Puchaka* (Amherst-Karen); *Rone* (Southern Shan States-Taungthu); *Sabaji-fo-me*, i.e., black granary insect (Tavoy); *San-fo* (Akyab, Kyaukpyu, Sandoway); *San-sin-fo*, *San-hsin-bo*, i.e., elephant like rice insect; *The-khwe-go* (Leiktho—Gebba-Karen).

Plate 6.

The Rice Weevil (Figs. 6, 7 and 8) is familiar to those who use rice as food. It is a small dark brown insect with a hard body, six legs and a long snout. It rarely flies but creeps all over the place when rice infested by it is disturbed.

It breeds mainly in the store in rice, wheat, barley, maize, sorghum (*pyaung*) and to a small extent in unhusked paddy. The weevil gnaws a small hole in the grain and inserts an egg into this hole (Fig. 1). The grub which hatches from this egg feeds by corroding the kernel of the grain. It grows and when fullgrown (Figs. 2 and 3) transforms into the sleeping pupa (Figs. 4 and 5) whence it ultimately issues out of the grain as the adult weevil. The weevil when disturbed folds up its legs and feigns death (Fig. 7). It feeds by gnawing into rice, wheat and other grains (Figs. 8 and 9). Ordinarily a generation takes about four weeks from the egg to the adult state. Each female lays several hundred eggs and the adult weevils live for several months.

The rice weevil is an insect with complete metamorphosis.

COCKCHAFER BEETLES (PO-KYAING-GAUNG) AND THEIR GRUBS.

(Anomala varians Oliv.)

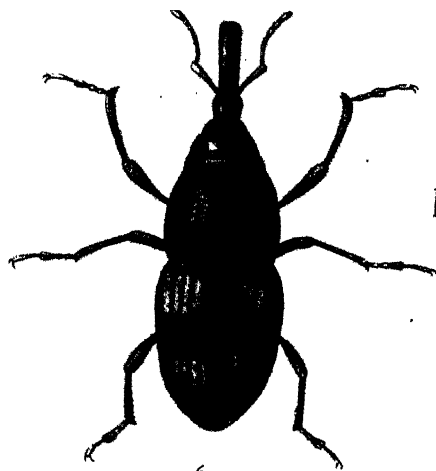
VERNACULAR AND LOCAL NAMES.—*Bi-bi-tho* (Leiktho—Gebba-Karen); *Garaw Ge* (Tenasserim-Karen); *Gon-gaung*, i.e., hump backed insect (Pakôkku); *Hkin-tawn-rawng* (Bhamo, Myitkyina-Kachin); *Kama-kamma*, *Kama-kanki* (Tenasserim-Talaing); *Mon-kaung* (Southern Shan States-Shan); *Podi* or *Podi-gaung*; *Po-hla-min* or *Po-lamin*, i.e., crescent shaped insect (Magwe); *Say-kauk* (Southern Shan States-Taungthu); *Wa-kin-tawng-rawng* (Myitkyina-Kachin); *Wa-la-hkun-tawng-rawng* (Ruby Mines-Kachin).

Plate 7.

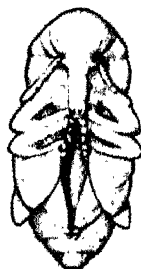
Po-di-gaung or "white grubs" (Figs. 3 and 4) are well-known to all cultivators as they sometimes occur in large numbers among the

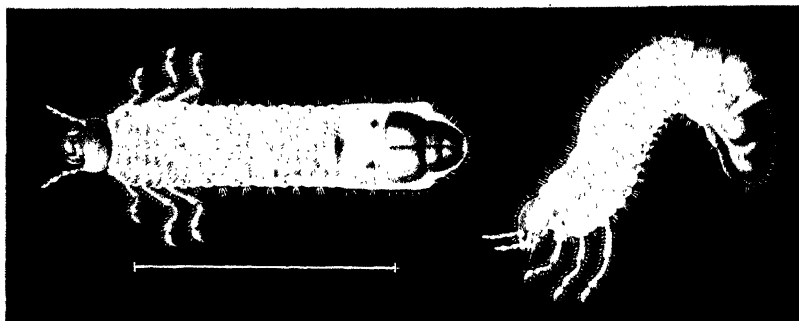


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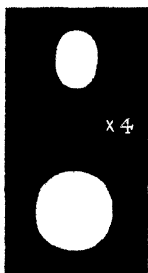


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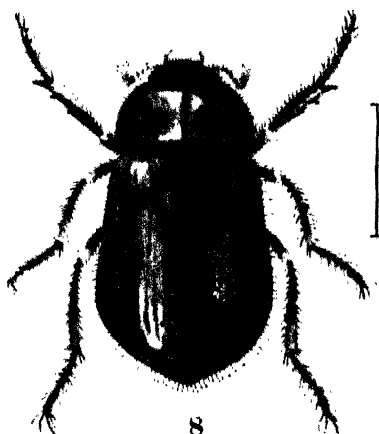
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Cockchafer Beetles
(*Anomala varians*)

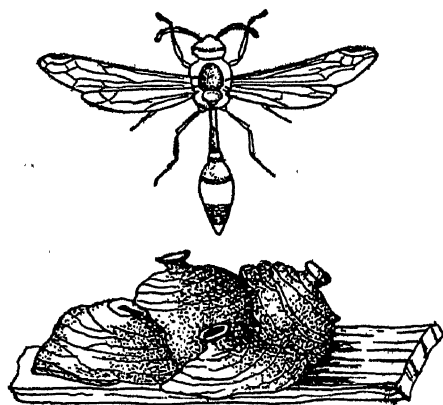
roots of *pyaung* (*Andropogon*), sugar-cane and other field crops as well as many garden plants and in dung and rubbish heaps. The roots of the young plants are eaten and the plants killed thus causing bare patches in the fields. All people, however, do not know from where *po-di-gaung* comes. The chafer beetles, *po-kyaing-gaung* (Fig. 8) which swarm out in the evenings after showers of rain in April, May and June are also well-known to all. Some of them are attracted to lights. Of the common ones, some are brown, some black and some black with white stripes on the back. The beetles themselves eat the leaves of plants and sometimes prove injurious. A black one eats sesamum and *chinboun* (*Hibiscus cannabinus*) leaves, a brown one eats mulberry leaves in some places and another eats rose leaves. Most of them, however, eat the leaves of wild plants.

The beetles swarm out in moist humid evenings after the first heavy showers of rain at the beginning of the hot weather. If there is a suitable crop growing in the neighbourhood they congregate on it, large numbers settling together. Frequently large swarms settle on whatever low bushes they find near the place of their emergence. Males and females mate. Before day-break they disperse and take shelter under the soil. The females then lay white roundish eggs (Fig. 1 as laid and 2 as it grows in size before hatching) among the roots of *pyaung*, sugar-cane, rice, groundnut and other crops and of grasses and wild shrubs and also among dung heaps and rotting leaves, etc., that is, in places where the grubs or *po-di-gaung* hatching from these eggs will find food. The grubs feed and grow (Figs. 3 and 4) and become full grown by about September. Then they form cells under the earth inside which they rest, transforming into pupa (Figs. 5, 6 and 7) after varying periods of rest lasting till about March-April next year. The beetle, *po-kyaing-gaung* (Fig. 8) develops from this pupa and issues at the swarming time. This is how *po-di-gaung* or chafer grubs and *po-kyaing-gaung* or chafer beetles appear. This beetle is an example of an insect with complete metamorphosis. Eggs hatch in one to two weeks. The grub or larva feeds for about four or five months and rests for about seven months. The pupal state lasts for about two weeks. The beetles live for about one to two months.

Parental and filial life.

Some insects are social like honey bees, ants and termites and the eggs and young ones throughout their nymphal or larval and pupal life

are looked after and nursed by the adults. The queen bee, the queen termite and queen ants are fed by worker bees, termites and ants.



Text Fig. 14.

WASP BUILDING MUD NESTS IN HOUSES. (AFTER LEPROY).

Some insects like the wasps which build mud nests in houses (Text Fig. 14) first of all stock the cells with caterpillars, or spiders, or bee-bread, etc., to serve as food for the future larvae and then deposit eggs, close the cells and do not come back to see what happens to the young ones. The grubs or larvae feed on the food provided, grow, pupate and ultimately develop into wasps. There are a few insects which either carry or look after the eggs.

The majority of the insects however do not take care of eggs and young ones but have the instinct of depositing the eggs in places where the future larvae and nymphs may have food. The mother butterfly of lemon caterpillars deposits eggs on lemon trees and takes no further care of eggs, caterpillars or pupae. The offspring too never know or look after the parents. This is the case with the largest majority of insects.

Food and Feeding.

The insects treated of above give examples of practically all classes of insects distinguishable as regards food and manner of feeding. Aphids suck plant juice. Mosquitoes, bedbugs and lice suck blood. Bees and butterflies do not pierce tissue but suck nectar from flowers. Common flies lap up food. Silkworms, lemon butterfly caterpillars, chafer-grubs, cockroaches, rice weevils, silver fish, termites and red tree ants bite, chew and swallow food.

As regards food, plant juice or parts of plants such as leaves, flowers, fruits, stems and roots form the food of the Large Brown Cricket, chafer grubs and chafer beetles, silkworms, aphids, lemon butterflies and their caterpillars, thrips and honey bees. Silver fish eat dead dry matter. The rice weevil eats dry seeds. Cockroaches eat almost anything, principally dead matter but also fresh. Red tree ants eat other insects or animals, after attacking them for the purpose. Bêd bugs and lice feed on human blood. Some mosquitoes feed on human blood while there are others which feed on plant juice, juice of ripe fruits or blood of animals. As every one has occasion to observe common house flies feed on many things, desirable and undesirable, such as sweets, ripe fruits, cooked foods, sores on the bodies of man and animals, dead animals and spittings, vomitings and purgings of human beings. Many biting flies suck the blood of cows, buffaloes, elephants and other animals.

Some insects take only one kind of food like silkworms which feed only on mulberry leaves. The lemon butterfly caterpillars eat several kinds of leaves. Others like the cockroach eat many kinds of food.

According to food and feeding habit insects are classified as follows:—

I. *Herbivores or plant feeders.*—They eat leaf, flower, fruit, seed, stem and root, mine under bark and between layers of leaves, bore flowerbud, fruit, stem, branch and root, form galls on leaf, stem and root and suck juice from leaf, fruit, stem and root.

II. *Parasites* external like head louse and internal, living and feeding inside the body of other animals and of other insects.

III. *Predators* prey on other insects. Wasps which build mud cells in houses sting caterpillars and spiders to death and use them as food for their young ones and are known as stinging predators. Some predators bite and eat their prey while others suck the blood of their prey.

IV. *Scavengers* or feeders on dead vegetable and animal matter like termites, dung beetles and their grubs.

Habitat.

Insects are found in all situations, in air, earth and water, on living plants, inside leaf tissue, flowers, fruits, stems, branches and roots of living plants, on and in dead rotting, soft and dry vegetable matter and on and in bodies of man and other living animals. Those which live in our houses and stores are called household insects.

Life-cycle.

The period from the time an insect is born to the time when it itself lays eggs after attainment of the adult state is known as its life-cycle. Out of the insects described above the life-cycle of flies and mosquitoes takes about one and a half weeks, that of silkworms about five to six weeks, that of chafer beetles and the large brown cricket about a year and that of the cockroach about one to two years. Different insects have different life-cycles. Climate and temperature affect life-cycles of all insects. In the hot weather the life-cycle is the shortest while in the cold weather according to the degree of cold it may be lengthened to three or four times the summer period.

Hibernation and Aestivation.

Climate affects the life of insects in another way. Some insects rest in the cold weather while there are others which rest in the hot weather and such resting is spoken of as hibernation and aestivation respectively. Hibernation and aestivation may be gone through in the egg, larval, pupal or adult state. Some insects undergo hibernation as well as aestivation successively.

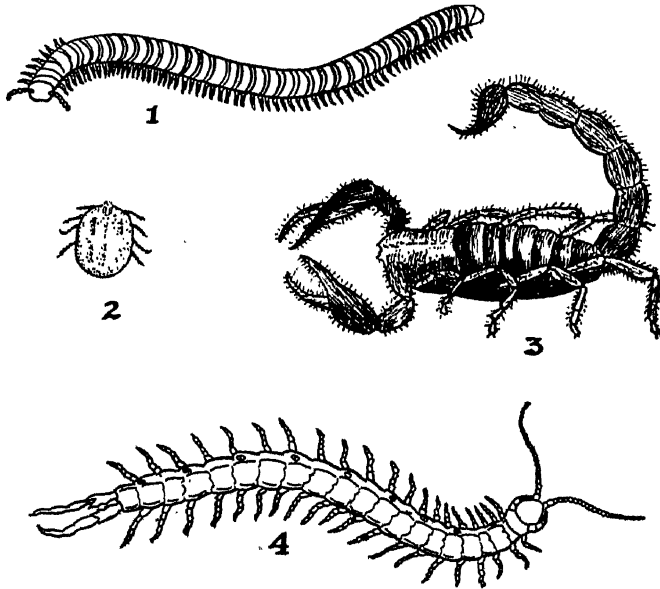
Behaviour of Insects.

Insects are observed to behave in a definite manner towards certain external stimuli. This response to an external stimulus is spoken of as "tropism" from a Greek word meaning turning. Many insects avoid sunlight and go into hiding at daybreak. This behaviour is negatively heliotropic. Many insects fly into flames of artificial light and are said to be positively phototropic. Other tropisms are chemotropism or response to chemicals, anemotropism or response to air-currents, thermotropism or response to temperature, hydrotropism or response to moisture, rheotropism or response to water-current, thigmotropism or response to touch and geotropism or response to gravity.

Classification.

All animals with three pairs of jointed legs are called insects although in their young or larval state they may or may not have any legs, as will be evident from the illustrations of various insects given in the book. Spiders and ticks with eight legs, centipedes and millipedes with many legs (Text Fig. 15) or earthworms with no legs are

not classed among insects. Except birds insects alone can fly. Some insects like bed bugs have no necessity of flying and have no wings.



Text Fig. 15.

COMMON ANIMALS WHICH ARE NOT INSECTS.

1. MILLIPEDE, 2. TICK, 3. SCORPION, 4. CENTIPEDE (1 AND 4 AFTER SHARP).

Adult insects are classified into the following broad orders according to presence or absence, number and structure of wings :—

Order I.—Aptera, *i.e.*, without wings—silver fish.

Order II.—Diptera, *i.e.*, with two wings—flies and mosquitoes.

Order III.—Lepidoptera, *i.e.*, with painted wings which are covered with scales—butterflies and moths.

Order IV.—Coleoptera, *i.e.*, with hard wings—beetles.

Order V.—Hymenoptera, *i.e.*, with clear glassy wings with only a few veins—bees and wasps.

Order VI.—Orthoptera, *i.e.*, with straight wings—cockroaches, crickets and grasshoppers.

Order VII.—Neuroptera, *i.e.*, with clear wings with numerous net like veins—termites and dragon flies.

Order VIII.—Hemiptera or rhynchota, *i.e.*, with wings half thick and half membranous and all with sucking mouth parts—bugs including aphids and such wingless insects as the bed bug and the head louse.

Order IX.—Thysanoptera, *i.e.*, with fringed wings—thrips.

How insects affect man.

We have to deal with insects throughout our life. They affect us in various ways, some injuriously and some beneficially, while some are of use and profit to us though the great majority have hardly any concern with us.

Those which affect us injuriously are included mostly among the herbivorous and scavenging insects. Some are parasites and affect our health or the health of domestic cattle. All these are pests.

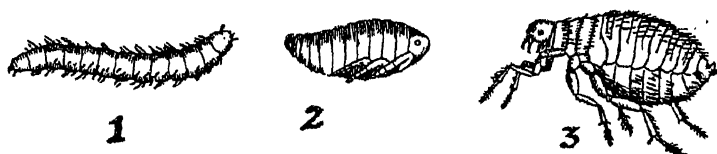
1. Many cause damage by eating or sucking the juice of field crops, vegetables and garden plants or by bringing about disease in them. These are field and garden pests, generally spoken of as crop pests.

2. There are several which damage food grains, pulses, etc., in the store and constitute what are called granary or store pests.

3. Some affect us in various ways usually causing annoyance in our houses such as ants, bed-bugs, mosquitoes, flies, cockroaches, white ants, clothes moths, etc. These are grouped as household pests.

4. Some affect our health and bring about disease and death among us as well as among our domestic cattle. When malarial mosquitoes bite a patient they suck up germs of the disease with the blood. The germs undergo development in the body of the mosquitoes and then these mosquitoes infect healthy persons. It is necessary for the malaria germs to undergo development in the mosquito in order to be able to infect man. This is how malaria spreads. Most highly malarial places have been rendered healthy by suppressing breeding of malaria mosquitoes. Some mosquitoes are suspected to spread dengue and other fevers. Bed-bugs are suspected to spread leprosy and other diseases. Lice are suspected to bring about certain kinds of fever. Some mosquitoes are known to cause yellow fever in America in the same way as malaria. Some flies are known in Africa to cause sleeping sickness which brings about sleepiness and death. Flies spread cholera, enteric, typhoid, etc., by infecting our food. Biting flies (as well as ticks) are known to bring about and spread diseases among cows, horses, camels, etc. In popular mind plague is connected with the death of rats. Plague is really caused by fleas (Text Fig. 16) which leave the dead rats and bite man. Fleas are small insects with their body compressed sideways and with legs suitable for jumping. They live on the body of cats, rats, dogs, etc., and on account of their compressed body are able to move among the hair without difficulty. They live wholly on blood which they suck from

their hosts and pass blood-red excreta in the form of thin pencils. Fleas breed among dust and dirt in dry places and pass through complete metamorphosis.



Text Fig. 16.

LIFE-HISTORY OF A FLEA.

1. LARVA, 2. PUPA, 3. FLEA. X10

Some diseases in plants also are brought about and spread through the agency of insects. The leaves get discoloured or turn yellow or white or are crumpled and crinkled and the plants in most cases cease to grow and do not bear fruit, or they die. Such infections are spoken of as virus diseases. The cause and transmitting agents of only a few virus diseases have so far been studied.

6. The beneficial insects include predators and parasites which destroy injurious ones. An account of the common ones will be found in the chapter on beneficial insects. Several beneficial insects have been used with success for controlling several serious crop and fruit tree pests and injurious weeds. Such beneficial insects are being sought throughout the world, and when found are carried from country to country and established and made use of wherever necessary. Frogs and other insectivorous animals are also utilised in the same way.

7. The useful insects include the well-known silkworms, lac insects and honeybees. A few are used as food and certain medicines like cantharidine are obtained from some.

Enemies of insects and means of protection against them.

Climate plays a great part in regulating insect life. Hot sun in summer, intense cold in winter and heavy rains and floods bring about the death of many.

Insects do not grow their own food. Therefore the presence and scarcity of food are factors of the first importance influencing increase or decrease in their number. When any plant is grown over a large area insects feeding and flourishing on it get a chance to breed on a large scale and to multiply in number. This is how man helps some pests.

There are many enemies preying upon insects. Some animals like ant-eaters, frogs, lizards, bats, etc., depend mostly on insects for their food. Birds such as crows, mynhas, owls, bee-eaters, king-crows, etc.

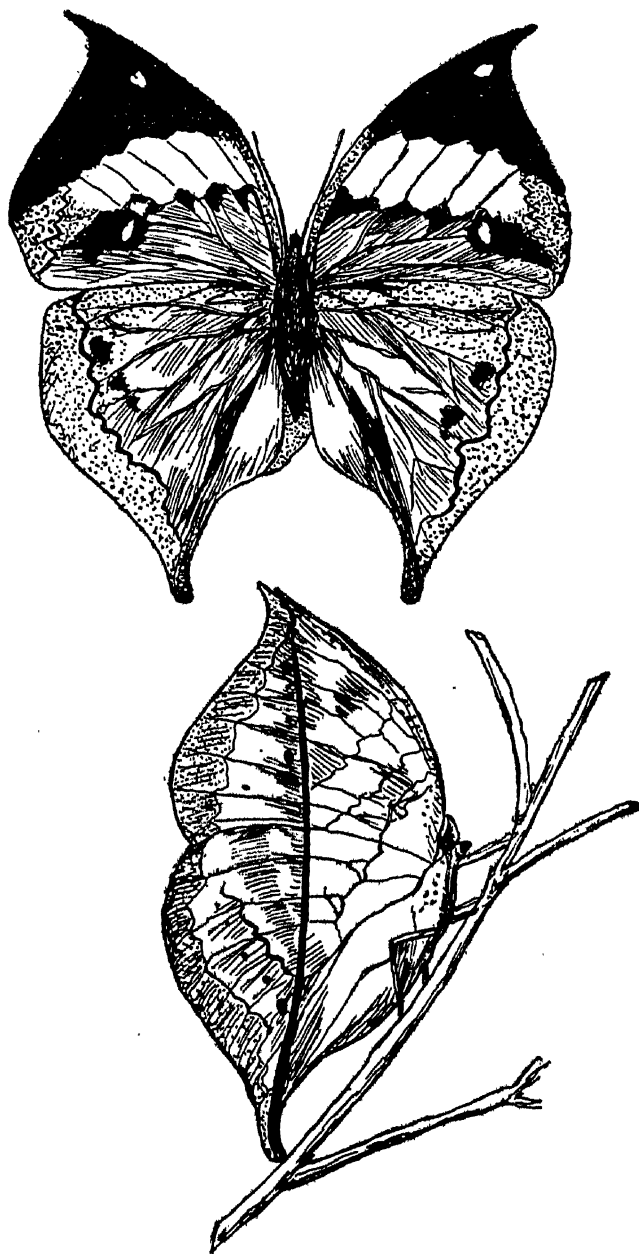
eat many insects. Many insects, for instance those classed as beneficial, feed only on other insects. Parasites like the fly parasite of silkworms, bring about the death of many. Every insect has one or more parasites and there is a constant and continuous struggle between the hosts and the parasites. When owing to some cause there is a decrease in the number of parasites the hosts have a chance to increase in number. This increase however gives a chance in the shape of abundance of host or food to the parasites to increase and very soon many hosts fall victims to parasites and a balance is brought about between hosts and parasites.

In nature there is a balance of life maintained both among plants and animals. If this balance is upset, for instance by growing at one place an abundance of a plant on which some insects flourish or by climatic changes or other reasons there may be epidemics of pests.

As will be evident now, insects have to contend against various kinds and numbers of enemies. To help them in this fight many ingenious devices are observed.

The majority of the insects work at night under cover of darkness as will be evident to every one from the number of insects which swarm about lights. Some insects are active in summer and rains and pass the cold weather in hibernation. While there are others which are active in the cold weather and rest during the hot weather. Then there are very ingenious devices to evade enemies. The resemblance of young lemon butterfly caterpillars to birds' droppings on leaves, assumption of a green colour like the green branches when they are grown and can no longer stay on leaves, protrusion of the hidden horn-like processes from the head and at the same time emission of a pungent smell are devices to deceive or scare away enemies. The colouration of most insects living on the bark of trees or on the ground is such and harmonises so well with the surroundings, that their presence can hardly be detected when they are sitting on the bark or on the ground. Many insects cover their body with dust or bits of dead leaf, sticks, etc., to hide themselves. Some insects look like sticks or leaves. The famous dead leaf butterfly displays brightly coloured spots on the upper surfaces of wings when in flight but at rest with wings folded up resembles a dead leaf completely to the extent of having a stalk and veins (Text Fig. 17). This is a case of protective resemblance: Wasps are armed with stings which birds and other enemies have cause to fear. In most cases insects having offensive weapons or unpalatable qualities are brightly and showily coloured with bands, stripes or spots of red, yellow and black. Many stingless and therefore harmless flies are observed to resemble the warningly coloured wasps in appearance. This phenomenon is

described as "mimicry." Mimicry is observed among many kinds of insects as well as among other animals.



Text Fig. 17.

DEAD-LEAF BUTTERFLY.

(*Kallima inachus*) (AFTER BASTIN.)

BENEFICIAL ANIMALS AND INSECTS.

Animals and insects which prey upon pests are beneficial to man. Mynahs, crows, owls and many other birds, frogs, lizards and many other animals which eat insects are friends of cultivators. Mynahs have been introduced from India into other countries to fight pests. Mongoose from India has been introduced for fighting rats but in new environments and probably on account of absence of other factors it itself has proved injurious for fowls and many ground birds in the new countries. A frog (*Bufo marinus*) in Poerto Rico has completely controlled chafer grubs and beetles in sugarcane fields and has now been introduced into Madagascar, Hawaii, Philippines and Australia to fight similar pests in sugarcane fields in those countries.

The predating and parasitic insects which prey upon injurious insects and also insects which kill and destroy injurious weeds are beneficial. Descriptions of a few common ones are given below.

LADY-BIRD BEETLES.

Plate 8.

The illustrations in the plate show the life-history of the common six spotted lady-bird beetle. The beetle (Figs. 7 and 12) as well as its grubs (Figs. 3, 4, 5 and 10) eat aphids. Wherever aphids occur the beetles come and deposit cigar-shaped yellow eggs in clusters among the aphids (Figs. 9, 1 and 2 show two eggs separately, enlarged, yellow when laid and changing to gray before hatching). Grubs hatching out of the eggs feed on aphids, grow, and then pupate (Figs. 6 and 11). Fresh beetles which emerge from the pupae also lay eggs. The life-cycle takes about three weeks, *viz.*, egg 4 to 5 days, grubs 10 to 13 days and pupae 4 to 6 days. Each female lays about 100 to 150 eggs. The beetle therefore increases in number fairly rapidly and soon controls the aphids. When sufficient aphids are no longer available the beetles fly to other places in search of other aphids colonies.

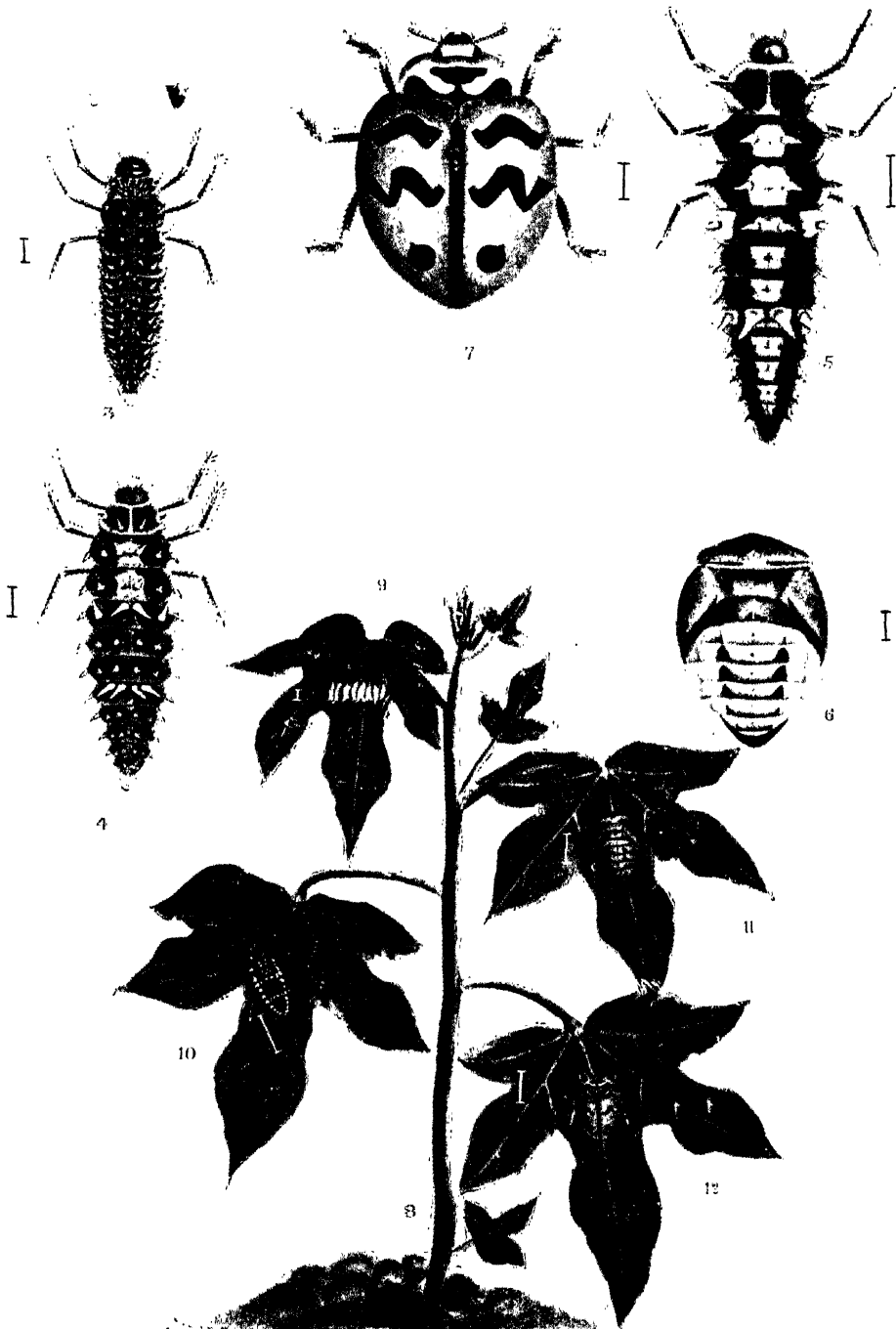
There is another common lady-bird beetle of the same colour as the six-spotted one but with seven round black spots on its back.

There are various kinds of lady-bird beetles which prey upon aphids, mealy bugs, scale insects, etc. Fig. 7 in Plate 12, shows one lady-bird beetle which preys upon scale insects on *nim*.

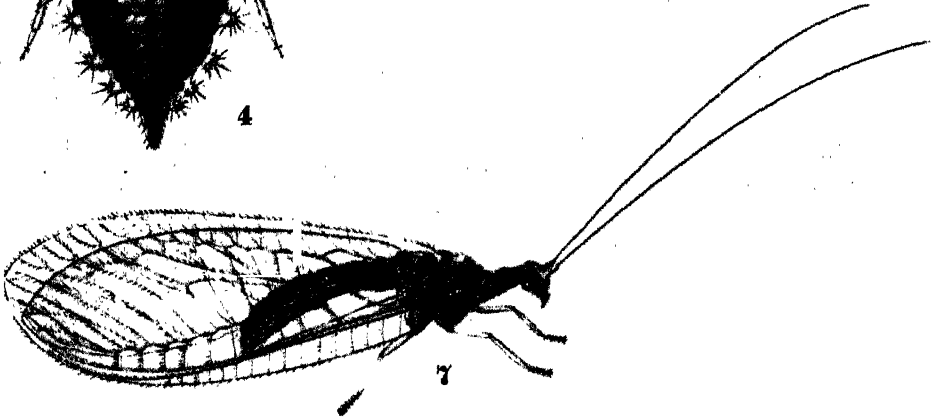
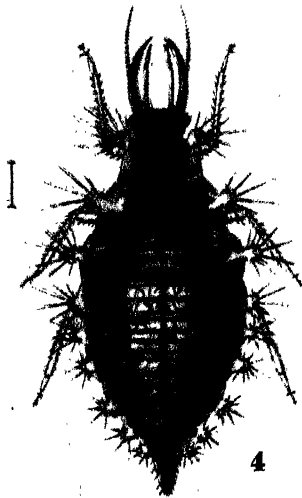
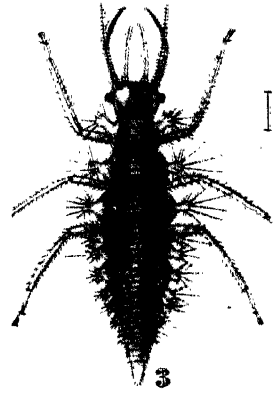
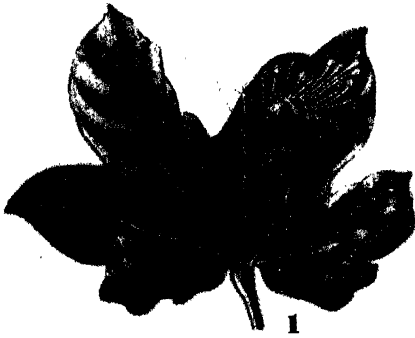
THE LACE-WING FLY. (*CHRYSOPA*).

Plate 9.

The lace-wing fly (Fig. 7) is another inveterate enemy of plant lice. It deposits eggs on long stalks (Figs. 1 and 2) among colonies of plant lice. The grubs hatching out of these eggs (Figs. 3—5) attack and suck the contents of the body of aphids and have the habit of piling up the



Six-spotted Ladybird Beetle
(*Chilomenes sexmaculata*)



The Lace-wing Fly
(*Chrysopa* sp)

Plate 10.



I



2



3



4



7



8

9

10

6



5



SYRPHID OR HOVER FLY.

skins of the victims on their back (Fig. 5) thus protecting themselves apparently against enemies. When fullgrown the grub spins a round silken cocoon (Fig. 6) which is also covered with aphid skins. The lace-wing fly emerges from the cocoon and continues doing beneficial work.

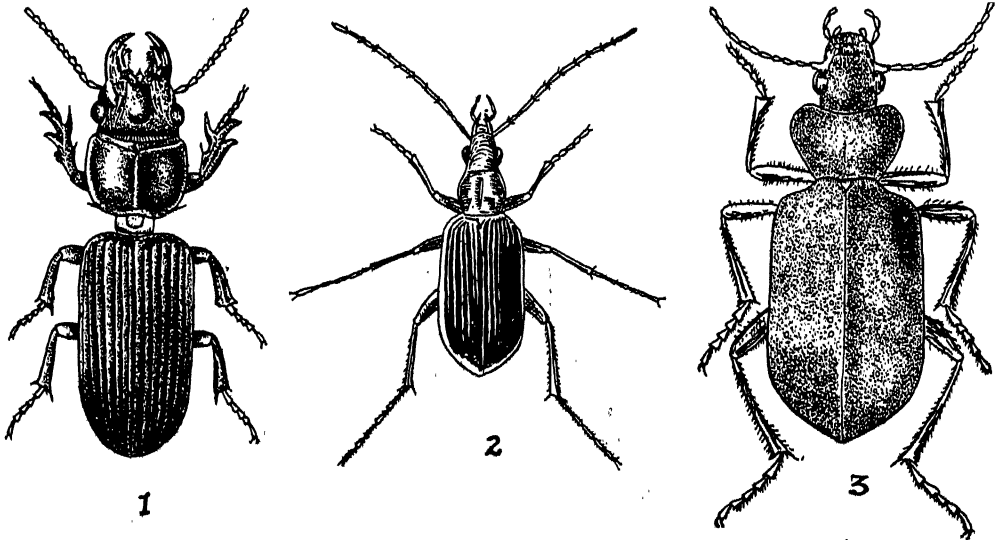
THE SYRPHID OR HOVER FLY.

Plate 10.

Maggots of syrphus or hover flies also prey upon aphids. The fly (Fig. 5) has a habit of hovering over aphid-infested plants and deposits elongated white eggs (Figs. 1 and 7) among aphid colonies. The maggots (Figs. 2, 3, 8 and 9) which hatch from these eggs move about striking the head here and there and when alighting upon an aphid the body and head are raised up in air (Fig. 9) and the contents of the body of the prey are eaten and the remains rejected. The maggot goes on feeding and destroying aphids in this manner and when fullgrown fixes itself at one place, contracts the body and pupates (Figs. 4 and 10). The fly emerges from the puparium and goes about in search of aphid colonies.

Predators and Parasites.

The members of the Carabid family of beetles and their grubs eat and destroy other insects among which many pests are included (Text Fig. 18). Many grubs of click beetles commonly known as wire worms (Text Fig. 39) are predaceous. The praying mantis (Text Fig. 19) frequently coming to lights, lives wholly on insects.



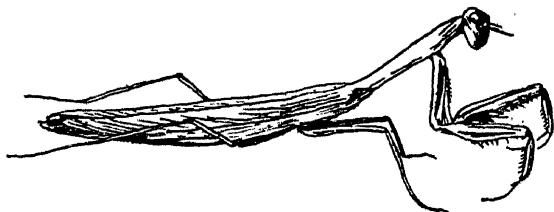
Text Fig. 18.

PREDACEOUS BEETLES.

1. *Scarites indus*, 2. *Chlaenius circumdatus*, 3. *Calosoma indica*.

(AFTER PUSA BULL NO. 89.)

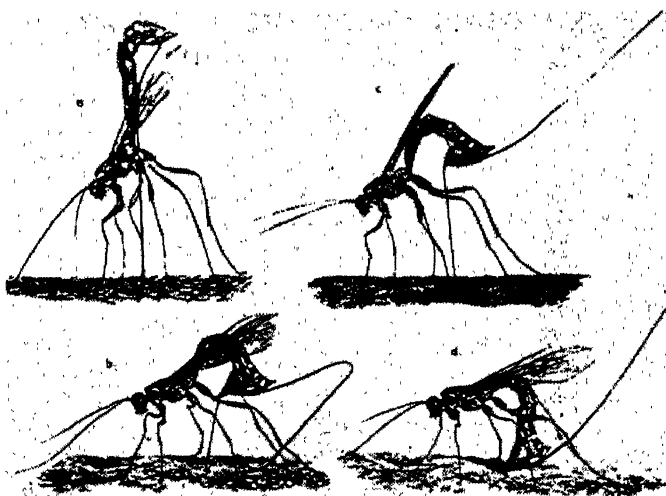
The insects which are highly beneficial are the parasitic wasps and flies. Parasitic wasps are more numerous and more efficient than parasitic flies and many of them search out their victims by burrowing underground or reach their victims inside plant tissue by means



Text Fig. 19.

PRAYING MANTIS.

of their ovipositor. Text Fig. 20 shows how a wasp is laying an egg on its victim, a wood-borer, by inserting the ovipositor through a thick layer of wood.



Text Fig. 20.

Rhyssa persuasoria, STAGES IN PROCESS OF OVIPOSITION.

THE PARASITE ON *Sirex noctilio* BORING CONIFERS IN NEW ZEALAND INTRODUCED FROM EUROPE.

AFTER BULL ENTL. RES. VOL. 26 (1935), PAGE 149.

Some predaceous bugs suck the body juices of insects. The bug shown in Text Fig. 21 is allied to the Green Bug (Plate 40) and has a similar life-history. Each female lays about 200 to 300 eggs which

hatch in about a week and the nymphs attain the adult state in about three weeks. Both nymphs and adults suck the juices of other insects. The entire family of Reduviid bugs feeds in this way.



Text Fig. 21.

PREDACEOUS BUG (*Canthecona*) SUCKING CATERPILLAR.

Wasps which build mud nests in houses (Text Fig. 14) sting and paralyse caterpillars, spiders, etc., and store them in the nests as food for their young ones.

PREVENTION AND CONTROL OF DAMAGE BY INSECTS.

Prevention and control of damage by insect pests call for different measures according to whether they occur on field crops, garden plants or in houses. Practicable measures are suggested where the pests are dealt with separately. Some general measures are discussed here which should be borne in mind by all and which go a great way in preventing the increase of pests and thus stopping damage by them. Some people talk vaguely of eradicating insect pests. This is impossible. The insects are there in nature like all other created beings. All that is practicable is to bring about conditions in which they are not able to increase unusually in number and so cause loss to us; or to take such steps as will kill the insects causing damage or prevent them from doing so.

Crops grown in the proper season and under conditions which enable them to grow with vigour seldom suffer from insect pests.

Those grown out of the season or struggling under unfavourable conditions usually suffer.

Some varieties of plants show a natural resistance to pests and should be selected and grown.

Pests usually have a season for activity. If this season can be evaded by selection of crops or suitable cultural methods the damage can be avoided in some cases. The case is best illustrated by the behaviour of the *leikpya* (borer) pest on hot weather (*mayin*) paddy grown round Paunglin lake in Minbu District. The local *mayin* was sown about December and the moths issuing out of winter paddy stubble at the advent of the hot weather in February and March attacked the seedlings which suffered severely. Introduction of a shorter lived paddy which could be sown in the latter part of March evaded this damage entirely.

Clean cultivation and removal of weeds, jungle and ground-keepers and out-of-season plants deprive the pests of the conditions which favour them and help them to tide over unfavourable seasons. For the same reason remnants of crops after harvest should be removed and burnt.

Good cultivation with deep thorough ploughing kills off many pests living in the soil both by the mechanical injury done to them and by the exposure to enemies and inclemencies of the weather such as hot sun, severe cold, dry air or rain.

In spite of the above precautions pests may and do occur and steps must be taken for their control.

The best method is to keep watch on the crops and destroy the first insects which occur on them. This is quite easy and simple and can be carried out by the cultivator himself or with the help of the members of his family. This is like a stitch in time saving nine. If this is neglected the insects multiply and increase in number, spread, and get out of control when they call for expensive and difficult measures. Rubbing off the eggs with the fingers, plucking off and destroying a few leaves with egg clusters or young insects, aphids or mealy bug colonies clustered on them, may stop further development and avert great loss. Such simple measures carried out by hand are usually quite sufficient if done in time. In Japan school children are given holidays and encouraged to pick off insects from paddy fields in the season.

Hand collection may not be quite sufficient in some cases. A simple hand net which can be made easily with a piece of thin cloth

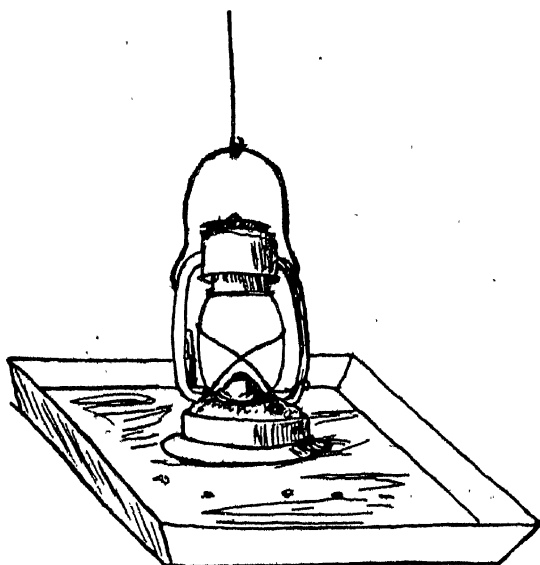
and bamboo sticks (Text Fig. 22) facilitates collection.



Text Fig. 22.

HAND NET.

Light traps can in some cases be used at night to catch night-flying adults of pests. An ordinary lantern with sufficient oil to burn the whole night is made to stand upon or hung from some support over a large shallow pan of water to which sufficient kerosene oil is added to form a film on the surface (Text Fig. 23). The whole thing is so placed that the light is visible from all round. The insects are attracted by the light, strike against the lamp and fall in the water.



Text Fig. 23.

LIGHT TRAP.

In some cases, for instance attack by scale insects, mealy bugs, tree borers, etc., such simple methods may not be sufficient and application of an insecticide is necessary. For biting insects a stomach poison usually with some form of arsenic is used which when eaten with the food has a fatal effect. For sucking insects what is known as a contact insecticide is used. It is sprayed on the body of the insect and has a choking, drying or corroding effect. Contact insecticides are made with oil, soda, soap, rosin, sulphur, etc. An insecticide or similar preparation can be used which when applied to the plant serves as a deterrent, the insects avoiding the treated plants. Fumigants act like a poison gas. For various reasons the use of poisons is objectionable in Burma. A few like barium carbonate and carbon bisulphide can, however, be used with a little precaution.

The number of insecticides, experimented with, recommended, patented or advertised is legion. Recipes for the preparation of a few simple insecticides are given below. These have been found to be of use especially in the case of common garden plants, vegetables, ornamental plants and in houses. Their use is referred to under the pests against which they are applicable.

Recipe No. 1.

Soap solution.

Half pound ordinary bar soap is sliced into thin pieces and boiled till dissolved in a kerosene tin and cold water is added to fill the tin full. It is used cold. Ordinary country made washing soaps can also be used but a little more of them is required. The solution is best prepared the day it is used. Half a pound of soft soap can simply be dissolved in cold water and sprayed. No heating is required in this case. The easiest way of dissolving soft soap is to put the soap in a piece of cloth and rub it between the hands in water.

Recipe No. 2.

Sulphur- soap solution.

After the soap is dissolved in the preparation of soap solution quarter pound flowers of sulphur should be added to it and boiling and stirring continued till the sulphur gets mixed and water added as in soap solution. It is used cold.

Recipe No. 3.

Kerosene emulsion.

Boil half a pound bar soap or $\frac{3}{4}$ pound country made washing soap in about a gallon ($\frac{1}{2}$ tin) of water in a kerosene tin till the soap is dissolved. Take the tin off the fire and pour about two gallons of kerosene oil (reddish cheap oil does well) in the soap solution while still very hot, stirring the solution briskly with a stick at the same time. The oil will

be emulsified into a thick white jelly which forms the stock solution. One to three pints of the stock solution in a kerosene tin full of water are strengths at which it is ordinarily used. Kerosene emulsion is better not used directly on tender plants or leaves as there is often free kerosene in it which has a scorching effect.

Recipe No. 4.

Crude oil emulsion.

This emulsion is prepared with soft soap and crude oil or what is ordinarily sold as earth oil. To prepare the stock solution heat one pound of soft soap in a tin or deep enamel cooking pan and add two pints of crude oil and go on stirring and mixing with a stick and heating. In a short time the oil will be emulsified into a thick jelly when it is ready. Larger quantities can be prepared in the same proportion. The emulsion keeps indefinitely. Half to $1\frac{1}{2}$ pounds in a kerosene tin full of water form ordinary strengths. The best way of dissolving the stock solution in water is to put it in a piece of cloth and rub between the hands in the water. Crude oil emulsion can also be prepared with bar soap if soft soap is not available. Slice 1 pound bar soap thinly and boil with $\frac{1}{2}$ pint water until the soap is reduced to the consistency of soft soap. Add two pints of earth oil and continue boiling, stirring and mixing with a stick. If the mixture separates into lumps and black oil add a little more water and continue cooking until a brown fairly thick emulsion is obtained. This is, however, less satisfactory than when prepared with soft soap.

Crude oil emulsion is very easily prepared, keeps any length of time and is more satisfactory and stronger than kerosene emulsion. Its solution is a good substitute for phenyle and can be used for washing floors against flies, fleas, etc. A rag smeared with the emulsion and wrapped round legs of tables, cupboards, etc., acts as a deterrent barrier against ants, etc. The emulsion applied on sores of animals keeps off flies and helps healing. It can be smeared on the legs of coolies working in leech-infested places.

Recipe No. 5.

Rosin compound.

One pound of washing soda is dissolved in one gallon ($\frac{1}{4}$ tin) of water in a kerosene tin and as the solution boils two pounds of powdered good quality rosin is poured into it and stirred with a stick. Boiling and stirring are continued, cold water in small quantities being added to prevent boiling over. Cooking is continued till the solution turns to a clear coffee colour and stops boiling over when cooking is complete. It can be tested by putting a few drops in cold water. It should form an amber coloured solution and not leave a white milky precipitate. One-fourth pound of sliced bar soap is now added and

boiled till dissolved. The stock solution is now ready and will be about two and a half to three gallons on account of the additions of water. It can be kept in a closed vessel for any length of time and used when required. If stored in an open mouthed vessel evaporation may ultimately reduce it to a thick jelly.

One, two or three pints of the stock solution in a kerosene tin full of cold water forms weak, ordinary or strong solutions respectively for use. Smaller quantities of the stock solution should be taken when it thickens due to evaporation.

Recipe No. 7.

Greasy band.

One pint castor oil and two and a quarter pounds powdered rosin are heated together sufficiently to dissolve the rosin but not boiled. It is applied as a ring round posts and tree-stems and remains sticky for about ten to fifteen days.

Recipe No. 6.

Bordeaux mixture.

One pound of copper sulphate crystals is put into a piece of cloth and hung in about one gallon of water in an earthen pot. The chemical dissolves in the course of a few hours.

One pound of unslaked lime is dissolved in about the same quantity of water in another pot.

The two solutions are poured at the same time and together into a third pot and water added to make up about four to ten gallons according to the strength required.

If the blade of a knife dipped into the solution shows brown deposits of copper more lime requires to be added.

Recipe No. 8.

Kerosenised dust or ashes.

Fine road dust or ashes are sieved through a muslin and a few drops of kerosene oil are added and mixed so as to impart a kerosene smell to the dust or ashes.

Recipe No. 9.

Baits for rats.

Commercial barium carbonate is thoroughly mixed with wheat flour at the rate of one pound in two pounds flour and made into dough with water and divided into pills of the size of a large pea. The hands should be smeared with sesamum or mustard or aniseed oil while preparing the baits as rats are very suspicious of the human smell. Addition of a little *ngapi* or dry fish baked over a fire and powdered makes the baits more attractive.

Baits can also be prepared by mixing barium carbonate with cooked rice and making into pills.

Baits should be placed out in the evenings and those found uneaten should be picked up and buried underground the next morning ; old baits are not taken by rats and children, birds or pet animals happening to eat them may suffer from bad effects. If necessary fresh baits prepared with a change of the food can be used after intervals of a few days.

Recipe No. 10.

Baits for cockroaches.

For cockroaches in houses a bait is prepared by mixing powdered borax or sodium fluoride with liquid jaggery or sugar syrup and the paste applied on pieces of paper which are placed where cockroaches are present. Cockroaches eat the paste and die in the course of a few days.

Recipe No. 11.

Mosquito and sand fly oil (Howlett's formula) which can be rubbed on exposed parts of the body and acts as a deterrent for several hours.

Oil of cassia—one part.

Brown oil of camphor—two parts.

Vaseline or salad oil—four to five parts.

Recipe No. 12.

Book solution.

One pint methylated spirit.

Half ounce carbolic acid.

Half ounce corrosive sublimate.

The solution is to be painted with a brush on the outside as well as the inside of covers of books. It should not touch the hand as it may cause sores.

A few other insecticides.

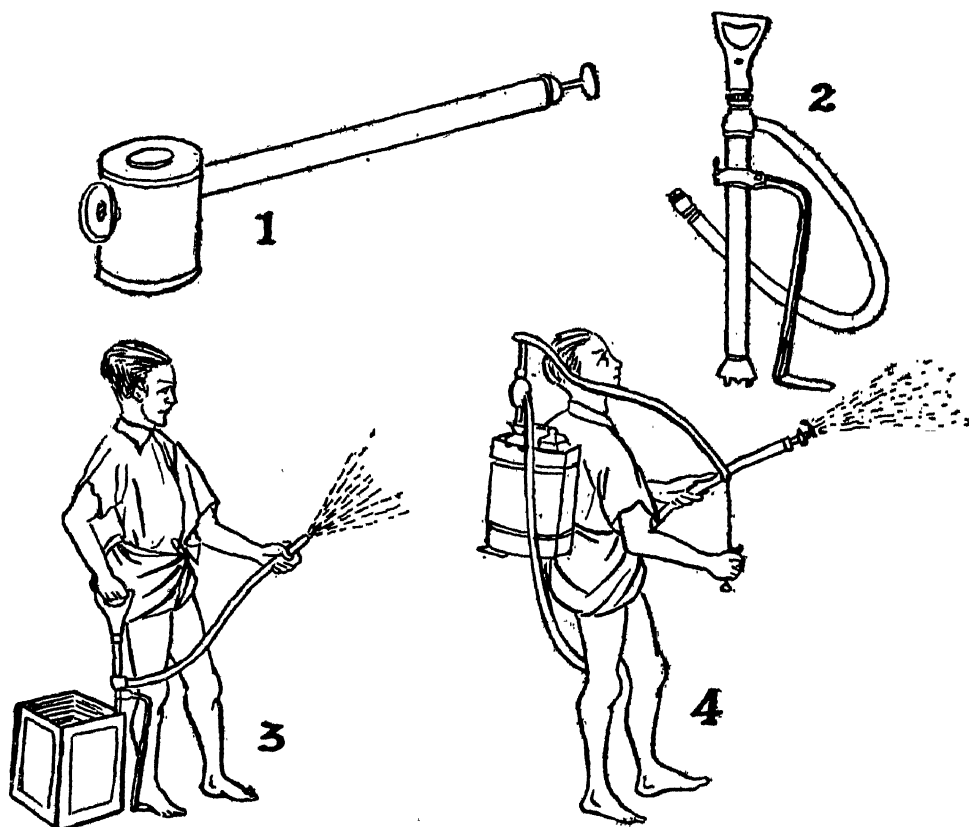
Flowers of sulphur, cyanogas, carbon bisulphide and crude creosote oil are of great use in many cases and are required to be purchased when wanted. Some precautions are necessary when carbon bisulphide and cyanogas are used. Carbon bisulphide is a liquid which evaporates quickly and the air when laden with its fumes becomes highly inflammable and explodes when coming in contact with fire. Therefore it should be stored in stoppered bottles in cold safe places and no fire should be brought near. Cyanogas is a dust which should be stored in airtight tins. It is a poison and its smell is injurious. Therefore precautions are needed when it is used. It should not be inhaled.

Application of insecticides.

Baits are simply placed out in suitable places and when placed in the open may be under cover of a split piece of bamboo as a protection against sun, rain or birds.

Kerosenised dusts, ashes or flowers of sulphur can be shaken down from a muslin bag.

Liquid contact and stomach insecticides to be effective require to be applied so that a film of them covers the insects entirely and the plants sufficiently so as to be swallowed by the biting insects. This can where possible be carried out with swabs by hand. But liquid insecticides are best sprayed with sprayers. A tin or brass hand sprayer (Text Fig. 24) can be used in small vegetable gardens. The most useful sprayer is, however, a bucket sprayer. It can be used with an ordinary bucket or a kerosene tin. Knapsack sprayers are more convenient and more useful but are difficult to keep in order.



Text Fig. 24.

1. TIN HAND SPRAYER, 2. BUCKET SPRAYER, 3. BUCKET SPRAYER IN USE,
4. KNAPSACK SPRAYER IN USE (1 AFTER LEFROY).

Fumigation with carbon bisulphide.—Carbon bisulphide is very useful for fumigating seeds, etc., infested by weevils and against tree borers. Against tree borers it is injected with a syringe into holes through which dust is being thrown out and all holes stopped so that the fumes may not escape. Fumigation of seeds, etc., can be carried out in various ways. Small lots can be treated in well-corked or stoppered bottles and jars into which the seeds and a little carbon bisulphide are put and the mouth closed well and left for 24 hours. The seeds are then poured out, aired well and stored in bottles and jars. For larger quantities ordinarily an airtight wooden box can be used in the same way, cracks, if any, in walls and joints being stopped with paper gummed on the surface. When required for use regularly and in the case of fairly large quantities a fumigating chamber in the shape of a square or oblong box with open top can be prepared with metal sheets or wood, having a water gutter all round the top and the cover with a flange which dips into the water in the gutter (Text Fig. 25).

Text Fig. 25.

SKETCH OF WATER GUTTER AND COVER FOR FUMIGATING BOX.

Carbon bisulphide can also be used to fumigate soils so as to kill off insects and other vermin present in it. For this purpose the soil should be fairly dry and loose in texture in order to enable the fumes to travel all round. The liquid is injected with a long-nosed syringe into a depth of about four to six inches and the whole closed with foot after removing the syringe. Injectors with means of regulating doses as well as depths at which to place the poison are available.

Biological control.

The control of injurious pests with the help of beneficial animals and insects is known as biological control and has been resorted to in several cases with great success. Great importance is at present attached to this method of control.

The case of the frog controlling chafer grubs in sugarcane field has been mentioned above. The most notable case of success is the control of the cottony cushion scale (*Icerya purchasi*) which threatened the orange-growing industry of California with extinction by means of a lady-bird beetle (*Novia cardinalis*) introduced from Australia. The froghopper pest of sugarcane in Hawaii has been controlled by the introduction of a bug which sucks the eggs of the froghoppers. In many cases parasitic wasps and flies have been introduced with more or less success.

Attempts are also made to breed and increase the number of predators and parasites under control in laboratories and liberate them in fields to do their beneficial work. Lady-bird beetles and parasitic wasps are bred on a large scale for such purposes.

Noxious weeds have also been controlled with the help of insects. A mealy bug has been utilized for controlling the prickly pear (*Opuntia*). The mealy bugs suck the juice of the plants and kill them. A fly which breeds in and destroys the berries has been utilized for controlling lantana in Hawaii.

Biological control methods are the work of experts and require organization.

PART II.

THE PESTS.

General Pests.

In this chapter an account is given of pests which may occur on any plant. Of each pest described here there are usually several species which however agree in their general behaviour. Therefore the species are not distinguished and stress is laid only on their behaviour with feasible methods of prevention and control. The pests included are—

1. Termites (white ants).
2. Mealy bugs.
3. Scale insects.
4. Aphids.
5. Mealy-wings.
6. Thrips.
7. Mites.
8. Jassids.
9. Rats.

TERMITES (WHITE ANTS).

The general life-history of termites has been illustrated in Plate 5 and described above. There are many kinds of termites. They are very useful as scavengers converting fallen leaves, useless wood and many other useless things into earth. They however become pests when they attack house, furniture, books, clothes, crops, fruit trees and various other useful things.

Measures for stopping damage by and loss due to termites depend on the kind of material to be saved.

Some timber such as teak is naturally resistant to termites and where practicable it is advisable to use such timber. Other timber liable to attack can be immunised by impregnating it with a chemical or poison or oil which termites avoid. Some very efficient processes have been evolved for this purpose and are in use. For ordinary purposes painting the timber with kerosene or crude petroleum oil or coaltar keeps off termites for varying periods. The best and at the same time fairly lasting treatment is to paint the timber, matting, etc., with crude creosote oil. The termite-resisting property of coaltar depends on the little creosote contained in it, but this soon disappears.

Damage to cabbage, cauliflower, etc., in the vegetable garden by termites can be prevented by impregnating the soil with a smell of kerosene. This is done by watering the soil once every few days with water in which kerosene emulsion or crude oil emulsion has been dissolved at the rate of about one pint or $\frac{1}{4}$ to $\frac{1}{2}$ pound emulsion respectively to one kerosene tin full of water (four gallons). It is better not to pour this water directly on the plants or to let it come in

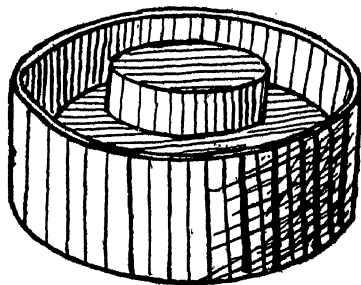
contact with the plants as there may be free kerosene in it which may cause scorching. The best plan is to pour it in a channel a few inches from the plants.

Fruit trees, roses and other plants can be saved from termites by the use of the same water applied at the base in the same way. Termites are active only in dry seasons and care is necessary only in particular seasons.

Occasionally termites cover entire stems and branches of trees with mud galleries like a casing. Usually in such cases the termites nibble off dead wood from the bark and no injury is caused to the tree. There need be no cause for alarm and no treatment is necessary.

Termites may build mounds in fields and compounds and even in houses. The mounds should be opened or dismantled and a bottle of petrol poured into the main gallery and they should be closed up immediately. Ordinary kerosene oil may help when used in the same manner. Cyanogas may be pumped in if available.

Termites are frequently very troublesome in houses, getting access insidiously into boxes, almirahs and racks and destroying clothes, books, etc., before their presence and damage are noticed. The surest preventive is to stand the legs of almirahs and racks on grooved bases of wood as illustrated in text Fig. 26 and the grooves occasionally filled with crude creasote oil. Cemented floors are not the surest protection against termites. Therefore this protective measure should be adopted in all cases.



Text Fig. 26.

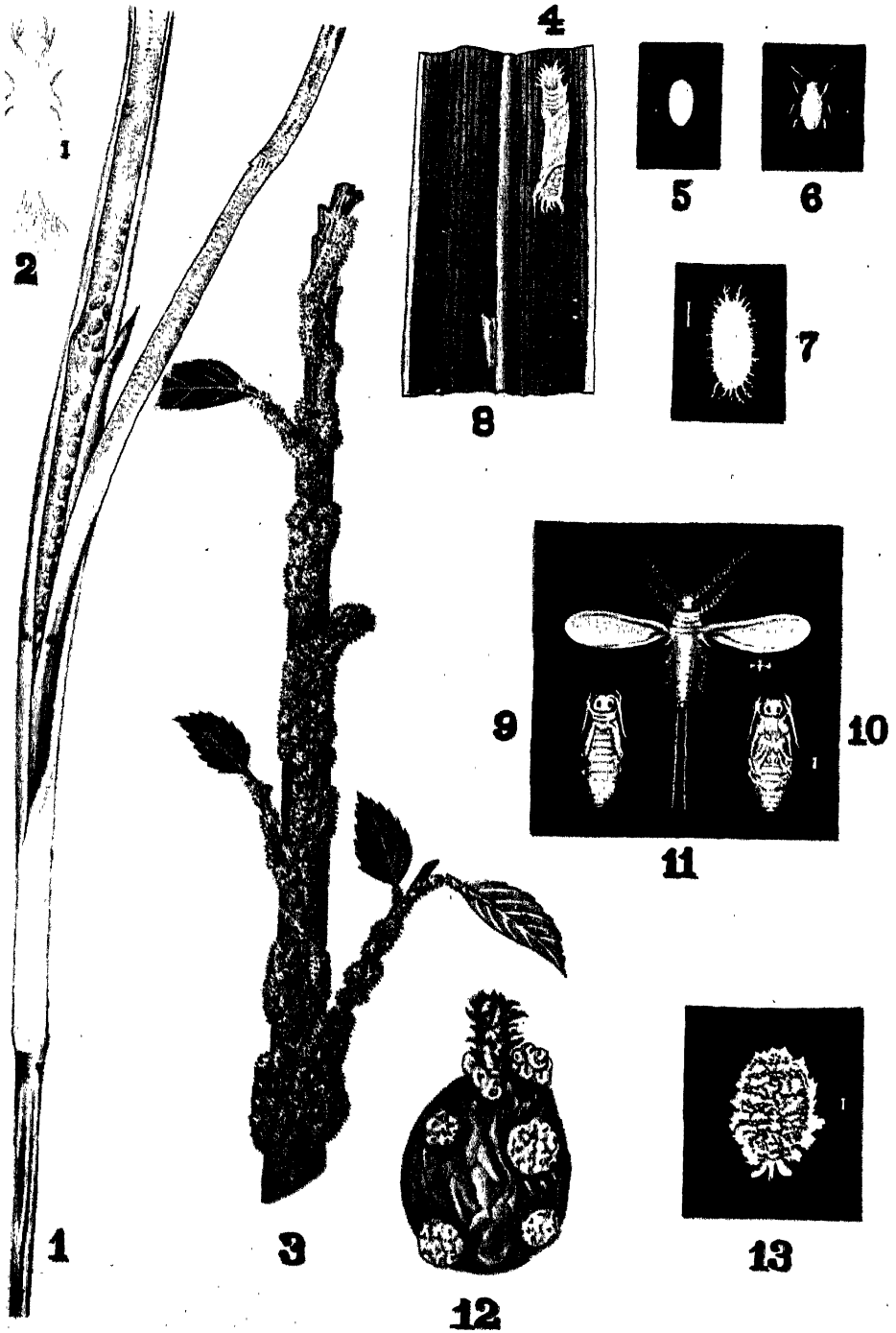
WHITE-ANT PREVENTING TROUGH.

MEALY BUGS.

VERNACULAR AND LOCAL NAME—*Posi-ne*, i.e., sticky insect (Tavoy).

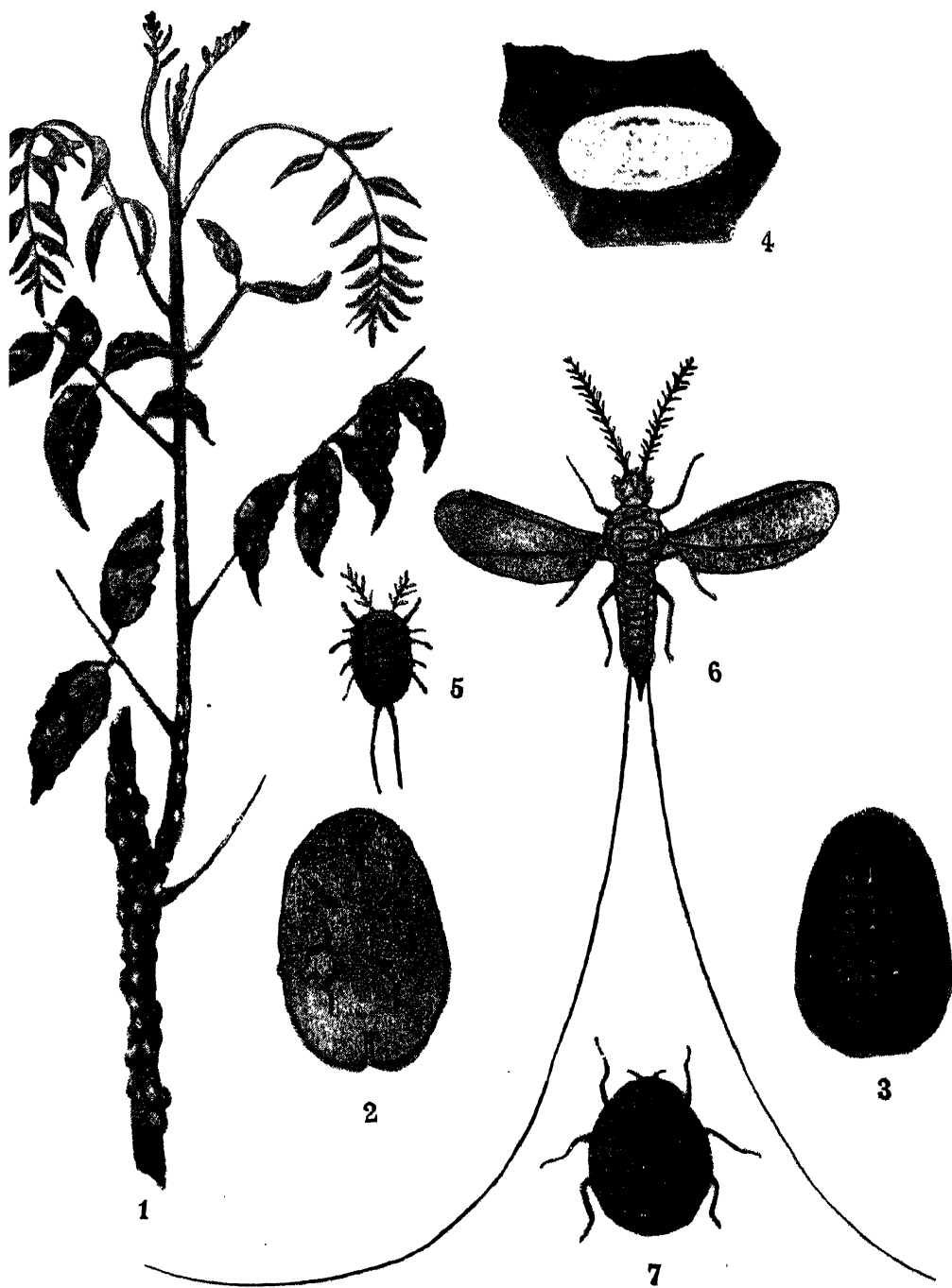
Plate 11.

Soft-bodied yellow or pink-coloured insects covered with a white mealy powder (hence the name mealy bug) or with a profusion of fluffy or waxy stuff, frequently occur on plants, sometimes covering entire leaves and stems. They are sucking insects and suck the juice of the plants on which they occur and when many occur the infested plants may die.



Mealy Bugs

Plate 12.



(PULVINARIA MAXIMA, GREEN.)
Scale Insect.

The plate shows four mealy bugs, one (Figs. 4—11) occurring on sugar-cane leaf, one (Figs. 1-2) on rice stems and also on sugarcane stems under leaf sheaths, one (Fig. 3) on cotton and hibiscus stem and one (Figs. 12-13) on potato tubers in store.

Mealy bugs have a peculiar life history. The females undergo hardly any metamorphosis retaining the soft grub like body and only growing in size (Fig. 7). The males, however, have complete metamorphosis and the young male bugs after a certain period of growth form a cocoon inside which (Fig. 8) they turn into pupa (Figs. 9-10) and ultimately issue out of the pupa as a two-winged fly-like insect (Fig. 11). The winged males fertilize the grub-like females (Fig. 7) which after fertilization produce a sort of woolly sac at the hind end (Fig. 4) and deposit many eggs, usually about 500 to 1,000 inside this sac. The female then dies in the same position. The young ones (Fig. 6) which hatch from these eggs crawl out of the egg-sac and on to other parts of the plant or to other plants and are frequently scattered by wind. This is how infestation spreads.

The best means of control for mealy bugs on any desirable crop, vegetables or trees is to spray them thoroughly with rosin compound solution at a strength varying with the size of the bug. Ordinary soap solution, unless the mealy bugs are small, is a little too weak but may be effective with repeated applications.

SCALE INSECTS.

Plate 12. (*Pulvinaria maxima* Gr.)

Scale insects are allied to mealy bugs and have a similar life-history but differ from them in having a more or less hard covering for the body and in being less motile, usually remaining fixed at one spot like a scale. There are various kinds of scale insects of different sizes, shapes, colours and with different body covers.

Scale insects as a rule are very prolific and cover whole stems and branches and even leaves of the infested plants unless controlled in time.

The illustration shows in Fig. 1 a *nim* (*Melia azadirachta*) branch covered with scales. Some of the females have ovisacs behind them. Fig. 5 shows a young one much enlarged. Fig. 3 is a grown up female. Fig. 4 is the cocoon of the male and Fig. 6 is the winged male.

Fig. 7 is a lady-bird beetle which preys upon this scale insect.

Scale insects are more common than mealy bugs. Small flat scale-like ones are likely to be and are frequently overlooked. Rosin compound solution as in the case of mealy bugs is necessary for their control.

APHIDS OR PLANT LICE.

(See Plate 1 and general description at page 7.)

Plant lice or aphids occur on all kinds of plants and trees. They may infest leaves, shoots, stems and even roots underground. As long as sufficient plant juice is available they breed on a large scale and the plants soon become covered with them. As their number increases

there is an increasingly heavy drain of the sap and the plants suffer, young and tender plants usually succumbing to the drain and drying up.

The general colour of most of the plant lice is green and their body is smooth. Some however are coloured, for example, those on safflower are dark grey or almost black, those on the milk weed (*Calotropis gigantea*) are bright yellow and those on tobacco are pink. Some develop a white powder or bloom while a few others develop a white filamentous wool on the body. The few known woolly aphids are serious pests, one on the roots of valuable fruit trees and another on leaves of sugarcane.

Aphids in most cases, and especially the leaf and stem infesting ones, can be easily controlled if one is prepared to undertake a little expense and trouble. A single spraying with an ordinary soap solution is sufficient to kill them. This is however hardly practicable on field crops but is perfectly feasible in garden crops, fruit trees, etc. In the case of field crops if the first colonies are destroyed in time further spread is frequently checked.

Care should be taken not to destroy the beneficial insects, *viz.*, lady bird beetles and their grubs, lace-wing fly grubs, hover fly maggots, etc. which soon appear in aphid colonies and in a short time bring the pest under control. If not present they should be introduced if possible.

MEALY-WINGS.

Plate 13. (*Trialeurodes ricini* Misra.)

Mealy-wings are bugs of small size looking in the adult state like tiny moths with two pairs of wings which are covered with a fine mealy powder and hence the name (Figs. 6—8). The adults lay eggs in clusters on the leaves (Fig. 1 and Fig. 2 a single egg magnified). The nymphs sit like oval spots or scales on the leaves (Figs. 3-4). Both nymphs and adults suck juice. The period of the life-cycle is short being only about 15 days. Therefore a mealy-wing occurring on a plant or crop multiplies quickly and increases enormously in number.

The plate illustrates a mealy-wing which is a serious pest on castor and occurs on the under surfaces of leaves.

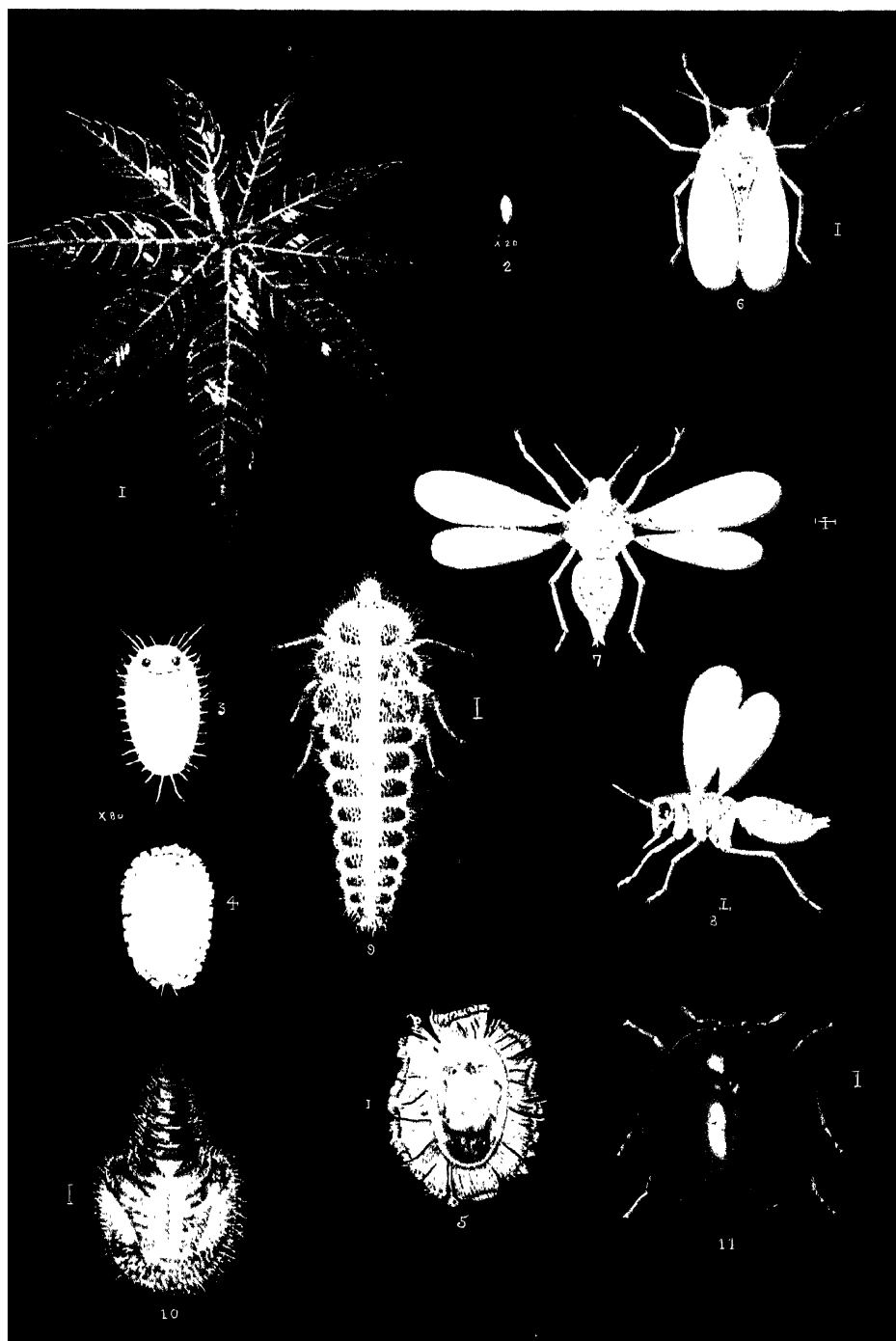
Fig. 9 in the plate shows a lady-bird beetle grub which feeds upon mealy-wing nymphs. Fig. 10 is its pupa and 11 the beetle.

Mealy-wings are amenable to the same methods of control as scale insects.

THRIPS.

Thrips (Text Fig. 3) are a general pest and may occur on any crop or plant and on account of their small size are likely to be overlooked and the ailment confused with something else.

Spraying with rosin compound solution at weak or ordinary strength is quite effective.



Castor mealy-wings
(*Trialenodes ricini*)

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SEASONAL PESTS OF CROPS:

THE GREASY CUT-WORM

Agrotis Ypsilon ROTT

A SERIOUS PEST OF *Rabi*

By

E. S. NARAYANAN,

Head of the Division of Entomology, I. A. R. I., New Delhi

AS in all the highly developed animal groups, in the case of insects also we come across various kinds of characters like the weak, the beneficial, the aggressive, the brave, the cunning and the cowardly. To the last category belongs the cut-worm, *Agrotis ypsilon* Rott. whose caterpillars hide themselves in the soil during the day and prowl at night, committing acts of vandalism on the young and tender plants under cover of darkness. These caterpillars not only feed themselves on the plants, which in itself is bad enough, but also destroy the tender plants by cutting at their roots. The damage caused by them is indeed very great sometimes.

In our country, the cut-worms are usually the major pests of gram, although at times a number of other *rabi*-crops are also attacked by them. Of the recorded species causing some kind of damage or the other in the Indian Union, *A. ypsilon* is undoubtedly the most widely distributed and also the most serious one. The pest has been reported from almost all the regions of northern India forming a continuous belt from the Punjab in the west to Bengal in the east and Madhya Pradesh in the south stretching as far as Nagpur. The *tal* areas near Mokameh in Bihar are the most seriously affected areas. Here the pests live and multiply by hiding themselves in the soil left moist by the receding floodwaters of the river Ganga, and destroy annually *rabi*-crops worth several lakhs of rupees. The cut-worms love a moist soil and drought is their dreadful enemy. The portion of the Gangetic plains of north India lying parallel and close to the Himalayas, seems to be their chosen abode. Outside India, the pest has been recorded from East Pakistan (Jessore and Rangpur) and West Pakistan (Lyallpur), North and South America, Europe, North Africa, Egypt, Japan, China, Tibet, Ceylon, Java, Australia, New Zealand and Hawaii. In some of these places it is popularly known as the black cut-worm.

Besides the gram crop which is severely infested year after year by this species of cut-worm, it has also been observed causing extensive damage to the other *rabi*-crops, especially those that are grown on

lands that remain under water during the rainy season. The pest has been found to cause damage to gram, groundnut, sweet potato, cauliflower, cabbage, lucerne and wheat at Pusa (Bihar), to gram at Gaya, to opium at Sahabad, to clover at Nagpur, and to potato at Jabalpur. Valuable leguminous crops like *masur*, *khesari* and peas growing in the *tal* or flooded areas in Mokameh on the banks of the Ganga in Bihar, suffer severely from the depredations of this pest year after year. Very recently the pest has been reported to be causing extensive damage to the potato crop as well as tubers at Patna, so much so that it is now believed to be a major pest of potato throughout the Indian Union. At the I.A.R.I. farm at Delhi and in the cultivators' fields in the Delhi State, the pest has been observed to infest gram, potato, tobacco and mustard, and vegetable crops like cabbage, cauliflower, etc.

HABITS AND HABITAT

Though the moths can be found in the field even in the beginning or middle of October, they appear in large numbers from November onwards only. The peak period of their activity lasts for four months, from December to March. During these months the caterpillars are found in large numbers and severely damage the tender *rabi*-crops that have sprouted and grown to a height of about six inches or more. During the day time moths hide themselves under dried twigs and leaves or in the cracks in the soil. When they are touched they feign death. If disturbed they shoot forth to another dark corner or a suitable hiding place by characteristic jerky movements. When at rest during the day their legs and wings are held close to the body. During the night, however, their wings remain horizontal and not applied to the body as in the day time. Also the body is as much above the ground as the legs can raise it.

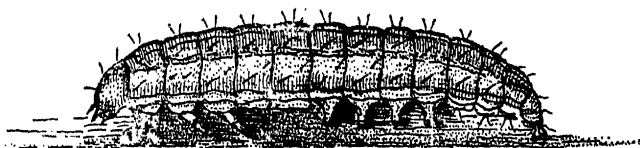
As soon as twilight sets in they come out of their hiding places and fly about in the field till it is completely dark. Then they start laying eggs on the host plants. Eggs are usually laid on the under surface of leaves or parts of stem which lie close to the ground. In

tal lands near Mokameh the moths have showed marked preference to lay eggs on wet or muddy lands just after the flood water has receded. Indeed they have been observed to fly long distances to reach the end of their journey, this favoured spot and their haven. A single female moth is capable of laying as many as 30 eggs at a time on a particular spot, and has been observed to lay as many as 350 eggs during her lifetime. Usually the eggs are laid singly or in small scattered groups. The egg is minute, pretty and dome-shaped, creamy white in colour and about half a millimeter wide from one side to the other. As it develops the creamy white colour changes to a dull hue with a blackening at the top where the head of the developing caterpillar is located. The incubation period of the egg varies from about two days in the summer to about nine days during the winter months.

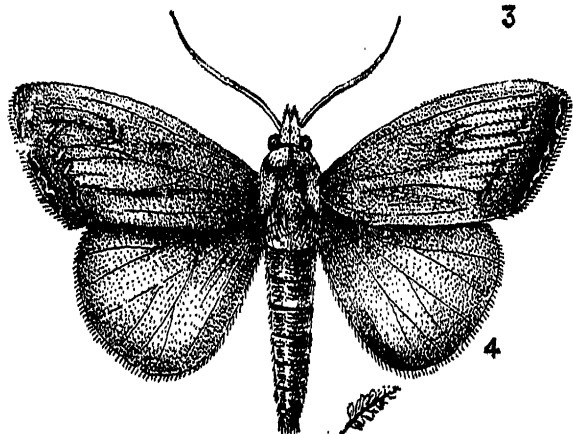
A peculiar habit of the freshly-emerged larva is that it has for its first meal the egg-shell from which it has emerged. Initial appetite thus satisfied it goes in search of its food. The newly-hatched larva is about 1.5 mm. long and is light yellowish-grey in colour. The young and the grown up caterpillars have got the peculiar habit of coiling themselves on the slightest touch and feigning death. For some time the young larva feeds upon fallen leaves on the soil or leaves that touch the ground. It has to pass through six stages before it becomes full-grown, when it measures about 1.75 inches in length. The full-grown larva is dark or dark brown in colour. These attack and feed themselves on the standing plants and often cut the plants at their roots. They remain hidden in the cracks or holes in the soil at a depth of about one inch during the day and assume the colour of the soil in which they hide and thus escape being noticed. They come out of their

"AGROTIS YPSILON" Rott.

1, 1a and 1b. Gram plants showing damage by the cut-worm 2. An egg 3. The caterpillar 4. The pupa 5. The moth 6. A caterpillar hiding itself during the day time 7. A larva pupating in the pupal chamber underground 8. The pupa underground



3



4



2



5



1



1a



1b



hiding places at night for the sole purpose of feeding themselves. It has been observed that sometimes after filling their stomach they carry some of the cut portions of the plant into their abodes. It is, therefore, not surprising that cannibalism should exist among the members of this greedy group characterized by excessive appetite. Young larvae are often attacked and consumed by the older ones and the older ones fight battles among themselves, and those that are defeated are mauled and eaten up. The larval period lasts for about a month and when it is very cold the duration is a few days more. In summer the larval period is shortened by several days. The full-grown larva pupates underground. The pupal period varies from about 10 days in summer to about 30 days in winter. The pupa measures about 20 mm. in length and is red brown in colour. Moths emerge from these pupae lying underground and crawl out of the tunnel that the larvae instinctively prepare while going underground to pupate. The moths mate soon after emergence and the female starts oviposition four to five days after its nuptials. ~~The total life-cycle of the pest varies from one to two months according to the climatic conditions.~~ Two broods have been observed during the peak season. The second brood is more aggressive than the first one and is responsible for more damage and destruction. During the lean days of rains and summer the pests lie and live scattered in weeds growing in waste lands and begin their normal activity with the advent of winter.

CONTROL MEASURES

The control of the cut-worms and particularly of *Agrotis ypsi-*

lon, which is polyphagous by habit, is one of the most difficult problems that have to be faced. As the caterpillars always remain underground and choose moist earth as their abode, their incidence and abundance can be controlled to a great extent by breaking up the sods in the fields to be sown. Particularly in low lands that are annually flooded by the swollen rivers, as in Bihar, ploughing the fields, say four to five times before sowing, will reduce the incidence of the pest to a very great extent. Flooding the areas that are suspected to harbour a large number of pests may also be useful. By this simple agricultural operation not only are many caterpillars killed by drowning, but also a large number of them comes to the surface where they fall victim to birds, parasites and predators. Clean cultivation and early ploughing of the fields that are going to be sown with *rabi*-crops, will give really good results. The following alternate control measures can also be adopted on a field scale to subjugate the pest:

(1) In small plots the caterpillars of the first brood may be hand-picked and destroyed by ~~ence of the pest later in the season.~~ searching the soil round the base of plants cut by them. This operation will certainly reduce the incidence of the pest later in the season.

(2) Baiting may be done against the caterpillars by using the following formulations. The bait should be scattered on the surface of the soil making sure not to drop it on the leaves of any plant. The quantity of the bait will vary from 10 to 20 lb. per acre according to the degree of infestation and should be scattered in the evening. It may be necessary to repeat this

process more than once to obtain satisfactory results

Wheat bran	100 lb.
Sodium arsenite, white arsenic or sodium fluosilicate	4 to 6 lb.
Water	Enough to moisten
or	
Wheat bran	100 lb.
Paris green	2 lb.
Water	Enough to moisten
Molasses	2 qt.

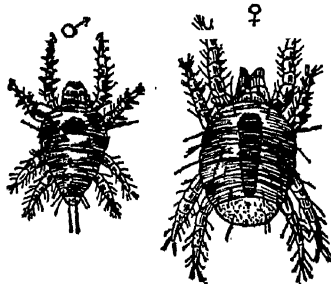
(3) In the case of tobacco and other crops that are first sown in a nursery seed-bed, dipping the top and the stem (not the root) of the plants at the time of transplantation, in Bordeaux mixture mixed with six pounds of lead arsenate or three pounds of calcium arsenate to 100 gallons of water will give satisfactory results.

(4) Dusting with six to ten per cent DDT or two per cent gamma-Benzene Hexachloride or calcium arsenate at the rate of 10 to 15 lb. per acre according to the degree of infestation will also yield satisfactory results. Great care has to be taken in the use of these dusts. Ordinarily, this should be done only under expert supervision.

(5) Dusting of DDT five per cent with some pyrethrum sold in the market as G-205-P or toxaphene five per cent has been found to give excellent results in potato fields. Many cut-worms come in contact with the insecticides and die. The damage caused to potato tubers is thus reduced and the yield is increased. These insecticides should, however, be used with great caution and under expert supervision.

MITES.

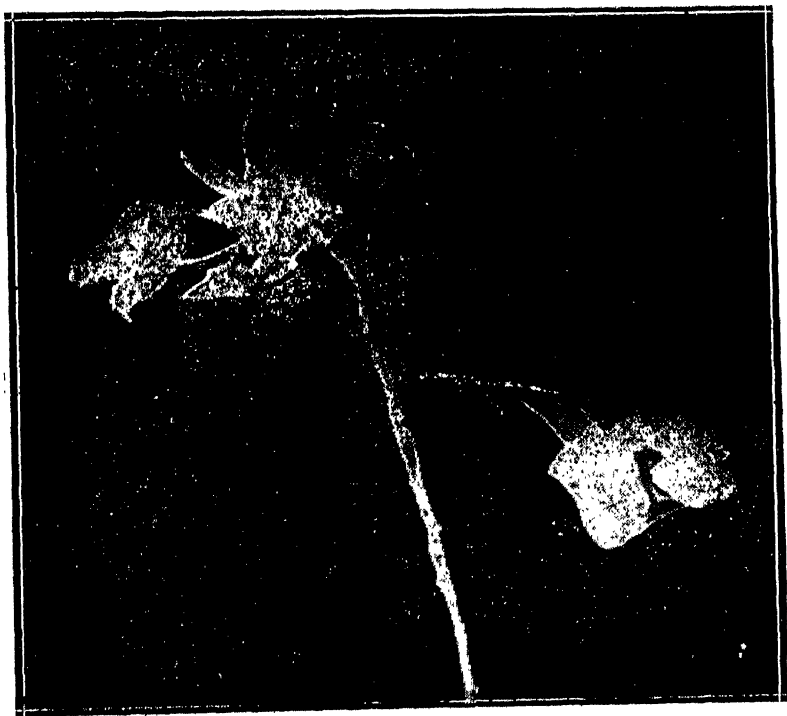
Mites are tiny spiders and not insects. The commonest ones are also called red spider on account of their colour (*Tetranychus bioculatus* W.M., Text. Fig. 27). They pierce and lacerate leaf tissue and cause



Text Fig. 27.

RED MITES (MUCH ENLARGED.)

the leaves to wither. Moreover they cover the infested leaves with a thin webbing of silk (Text Fig. 28). They occur on many crops, vegetables and fruit trees and cause a lot of damage.



Text Fig. 28.

COTTON PLANT AFFECTED BY REDSPIDER.

periods of from 8 to 15 years and others are said to flower after long intervals of about fifty or a hundred years but they may flower in different years in different regions. Rat plagues are not therefore very common but occur after intervals of some years. Even when bamboos do not flower other suitable conditions may be present in some localities enabling rats to breed freely. In such cases although the rats may not constitute a widespread plague they increase sufficiently to prove a local pest.

Rats prove to be occasional serious pests of *taungya* paddy. They live in the jungle and make inroads into the paddy fields at night. Field paddy situated in the midst of rat infested hills also suffers. Some rats take up temporary quarters in holes in *kazins* but leave the fields when the paddy is harvested. In the plains of course all live in holes in the *kazins*. In the hills usually plenty of other food than paddy is available. Therefore rat plagues take about two or three years to run out their course. In the plains hardly any food is available after the paddy is harvested. Besides in the open country rats are exposed to the attack of many enemies. Hence in the plains rat plagues usually do not last for more than about a year.

In years of rat-plagues in the plains the rats may begin by picking up the seeds from the seedbeds and then cut the seedling plants, afterwards damaging the ears of grown-up plants. In the hills however, it is mostly when the crop comes into ear that the rats turn their attention to the paddy.

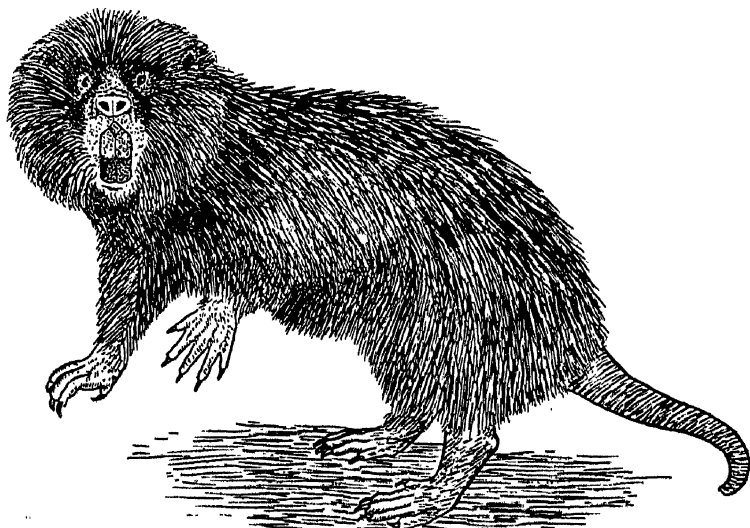
In the hills the people (Karens, Kachins, etc.) make ingenious bamboo traps to catch and kill rats, the traps being set in the rat runs. Each of these traps kills only one at a time and has to be set up again. Earthen pots used as described below have been found useful in trapping many rats at a time.

Sink deep wide-bellied and narrow-mouthed earthen pots in the ground or *kazins* and place earth all round so that rats may easily walk up to the mouth. Fry oil-cake well over a fire and pound it. Similarly fry fine husk dust obtained in cleaning rice (*phwenu*). Mix the two and place a little inside the pot and smear a little on the mouth of the pot. The smell of fried oil-cake and *phwenu* attracts the rats which drop into the pots but cannot get out. If it is found that some are getting out, place a little water in the pot and no rat will be able to jump out. The rats should be taken out and killed every morning and if necessary the water should be changed.

The rats which live in the *kazins* in the fields make rather shallow holes which can be opened with a few strokes of a spade or pick-axe. As litters are present in these holes many can be destroyed by opening them. They can be fumigated if arrangements for fumigation are possible.

These are simple means which if organized in a systematic manner may afford much relief. On particular days all people should turn out and hunt and kill the rats in the fields.

Baits can be judiciously used in all situations with good results. In the case of rat plagues application of baits requires to be properly organized.

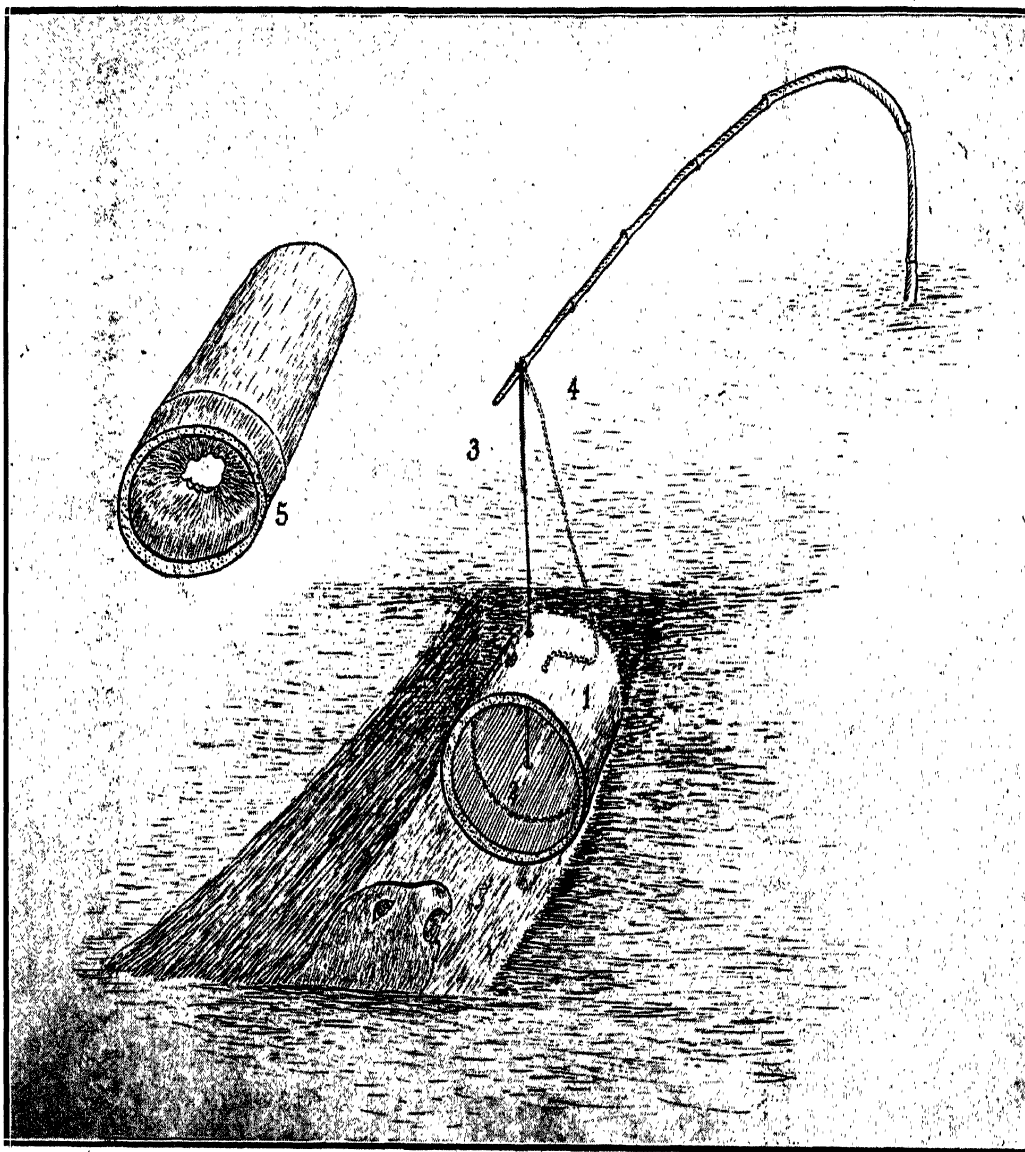


Text Fig. 30.

THE BAMBOO RAT OR MOLE RAT (AFTER BEDDARD).

The mole rat or bamboo rat (*Cannomys castaneus* Blyth.) known in many places under the common name of *pway* (Text Fig. 30) occurs both in the hills and plains as a persistent pest throughout the year. It usually lives solitarily and eats roots of plants like mulberry, *pessinngon*, etc., cutting even grown up plants with thick roots and killing them outright. A lot of damage is caused in this way unless control measures are adopted systematically. The rat burrows its way under the surface of the ground throwing up large amounts of earth here and there along its passage. The burrow of a single rat is a long one extending over a large area in different directions. The animal has the peculiar habit of closing the burrow with earth behind it. Therefore fumigation is difficult. The passage has to be dug open at many places and cyanogas pumped in but usually with many failures. Bamboo traps illustrated in Text Fig. 31 have been found to be successful against this pest. The traps are inexpensive. Several of them have to be kept ready and used whenever necessary. The rats migrate into mulberry plantations and other places where they find food. Therefore a careful watch has to be kept and traps should be

used on the first indication of their presence in the shape of earth thrown up. Bait is not successful against this pest.



Text Fig. 31.

THE BAMBOO RAT TRAP.

1. BAMBOO JOINT ABOUT 9 OR 10 INCHES LONG WITH THE OPENING ABOUT 2½ INCHES IN DIAMETER. THE END BURIED IN THE EARTH IS SHOWN IN 5. A TIGHT STRING 3 PASSING THROUGH HOLES IN THE BAMBOO CYLINDER IS TIED TO THE BOW, 4. A LOOSE STRING IS HIDDEN IN A GROOVE 2 INSIDE THE CYLINDER. WHEN THE RAT CUTS THE TIGHT STRING THE BOW GOES UP TIGHTENING THE LOOSE STRING ROUND ITS NECK.

PESTS ON RICE.

Rice is the most important crop in the province, some variety or other being grown throughout the year. The varieties are broadly described below with the time of the year when grown :—

Hot weather rice.—(1) *Mayin*, grown under irrigation around lakes and other accumulations of water between about December and June.

(2) *Kaukti* and *Kaukyin*, grown usually under canal irrigation between about March and August.

Autumn rice.—*Kauklat* grown between July and November.

Winter rice.—*Kaukkyi* forming the largest crop grown between about July and January.

Taungya rice grown under shifting forms of cultivation on hill sides in the hilly regions. Trees and all vegetation on hill side, called *taungya*, are cut down about February and burnt on the spot when dry. Seeds are planted in small pits about May-June and the crop is harvested about November. *Taungyas*, although in some cases several acres in area, are situated in the midst of miles of forests and hills all round. This rice is sustained by heavy and almost continuous showers of rain as no water can stand on the steep hill sides.

The rice crop fortunately does not suffer from any serious widespread pest, although some pests frequently prove bad under certain circumstances and in certain areas. Thus the *taungya* paddy is liable to damage by rats as described above. Isolated *mayin* situated in the midst of large *kaukkyi* areas, usually sown early in December and January, is liable to damage by the stem borer (*silpo*) called *leikpya*, the moths of which issue on a large scale from *kaukkyi* stubble as soon as it begins to get warm after the winter and congregate and oviposit on the green *mayin*. *Kaukti* and *kaukyin* being sown later have not been observed to suffer in this manner.

There are several sporadic pests which usually affect the *kaukli*, *kaukyin*, *kauklat* and *kaukkyi* varieties but which never occur on a widespread scale though often causing some or fairly serious damage in localities where they appear.

The only persistent and widespread pest is the stem borer (*silpo*). Its activities however being spread over the whole country have not been observed to cause serious damage. Individual fields in rare cases only have shown dry ears to the extent of about 6 to 10 per cent. But damage in a whole locality is in the neighbourhood of about '05 to '5 per cent.

Some diseases of growing paddy not due to insect activities are frequently ascribed to insects. *Gwabo* and *gwinna* are two words

commonly used in different places to describe a diseased condition characterized by the following symptoms, *viz.*—

- (1) in bad cases the ears usually fail to emerge or one ear may emerge out of four to eight plants ;
- (2) in the ears which may emerge some or all the grains may fail to develop ;
- (3) the grains which are formed show a dark discolouration to a greater or lesser extent ;
- (4) in a virulent form the plants in later stages look scorched with hardly any ears.

Stem-borers (*sitpo*) are usually found in some of these plants but are not the cause of the disease. People in *Mon* and *Man* canal areas call the disease also by the name of *pya*, *sitpo*, *hteikpo* and *yemhwa*. Barrenness is frequently observed in patches and is probably connected with this disease.

Myitpo is a word used in Shwebo District to describe stunted growth of paddy observed in several other places also. Borers (*sitpo*) and Pink Mealy Bugs are frequently found in the stem of some of the affected plants but cannot be taken to be the cause of the disease.

The crop suffers from the following insect pests, *viz.*—

- in the seed bed from Thrips and the Swarming Caterpillar ;
- in the young state from the Stem Gall Fly, Crabs and the Case Worm ;
- in the grown state from the Leaf Butterfly, the Hairy Caterpillar, the Leaf Binding Caterpillar, the Rice Hispa, Stem Borers, Jassids and Mealy Bugs ;
- in the ear-forming state from the Ear Bug and the Grain Nibbling Caterpillar.

Thrips.

Text Fig. 3.

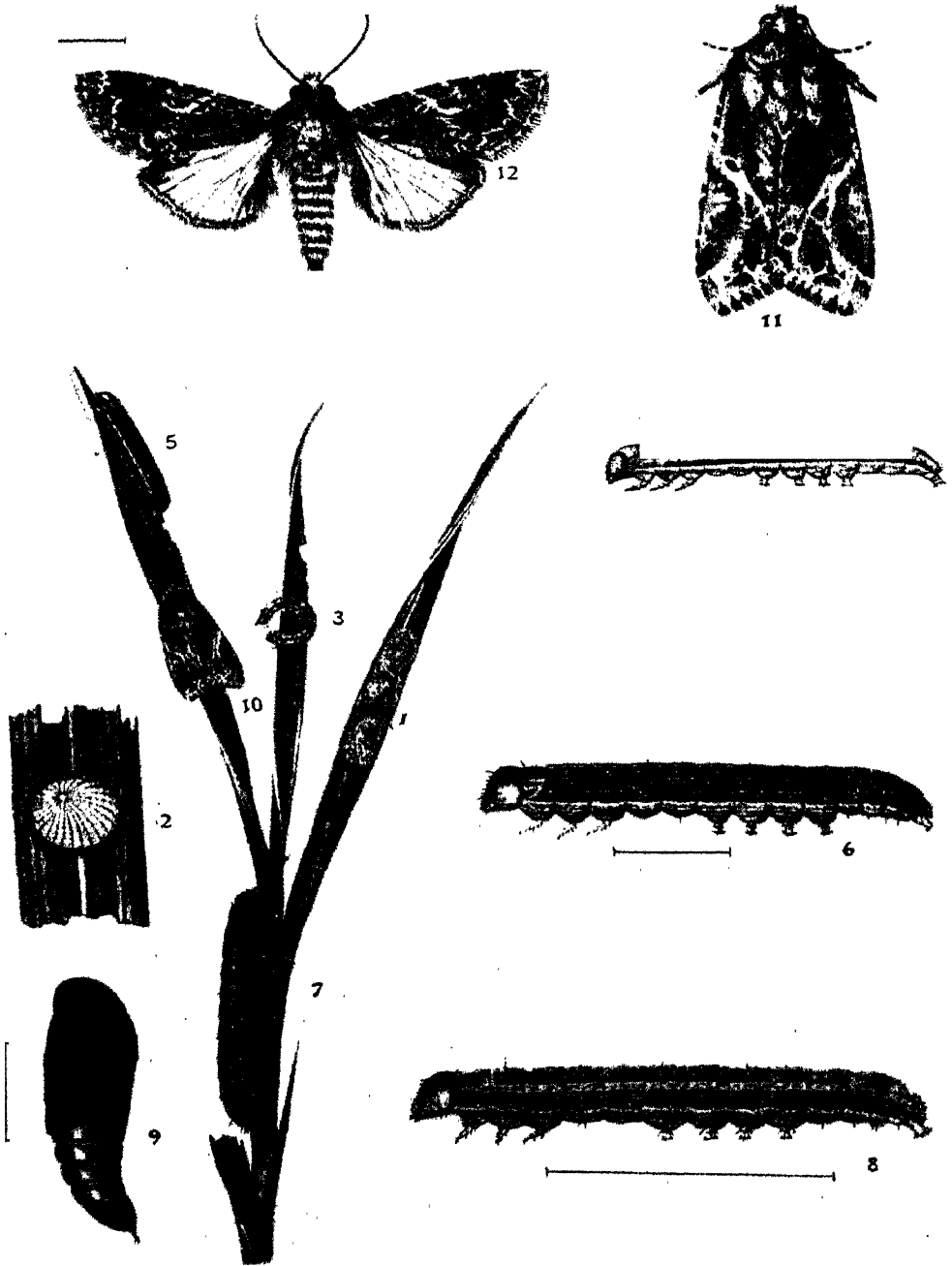
Occasionally a kind of thrips occurs in seedlings affecting the leaves and causing them to dry. Droughty conditions help the insect. Spraying with soap solution or rosin compound solution is a sure remedy. Filling the seed bed as far as possible with water and, dipping the leaves in water by bending them with a rope or bamboo passed over them also helps.

THE RICE SWARMING CATERPILLAR.

(*Spodoptera mauritia*, Boisd.)

VERNACULAR AND LOCAL NAMES.—*Aywel-po* (Amherst) ; *Garin* (Tenasserim-Karen) ; *Kama-Hakum* (Tenasserim-Talaing) ; *Kwel-na-po*, *i.e.*, affecting entire plot (Myingyan) ; *Mon-cho* (Yaunghwe-Shan) ; *Nga-hmyaung-daung* ; *Pin-pyat-po*, *i.e.*, plant cutting pest (Akyab) ;

PLATE 14



SPODOPTERA MAURITIA.
Rice Swarming Caterpillar.

Po-daung-de (Shwebo) *Saba-nye-net-fo*, i.e., eating rice plant at night (Akyab); *Say* and *Say-am-bu-myi* (Southern Shan States—*Taungthu*); *Shauk-su-fo* (Henzada).

Plate 14.

These caterpillars (Figs. 3—8) occur as a pest of seedling paddy usually in seed-beds which are often wholly destroyed and may occur also in transplanted fields. They feed for about three to four weeks and then enter the earth and change to brown pupae (Fig. 9) in which state they sleep for about ten days and then issue out as moths (Figs. 10—12). These moths lay small poppy-seed-like eggs in clusters on the leaves and stems and cover the clusters with brownish coloured hairs (Fig. 1). Fig. 2 shows one egg highly enlarged. The egg-clusters look like very small masses of brownish hairs stuck on the surface. Each female moth lays about 300 to 400 eggs. The caterpillars hatch from these eggs in about five days. Rice is not their only food. They feed on many kinds of wild grasses. In some years under favourable conditions their number increases very much. The resultant moths fly to paddy seed-beds and lay eggs on the seedlings. The innumerable caterpillars which hatch from these eggs at first nibble the surfaces or eat only small bits of the leaves. When, however, they grow they eat voraciously and devour whole fields in a short time and then move on to other fields. Generally the eggs and young caterpillars are overlooked. The caterpillars attract attention when they grow and begin to eat voraciously. At this stage nothing but prompt and vigorous measures is of any avail. Usually there is no second attack.

The pest does not occur regularly but only occasionally after uncertain intervals which may be of several years. There is no means of knowing beforehand when and where it will appear. Therefore it is not possible to take any precautionary or preventive measures.

(1) The best thing for the cultivators is to keep watch on their seed-beds and if the appearance of the pest can be detected in the egg stage, control is quite simple. Bits of leaves containing the egg masses can be pinched off or the egg masses can be crushed between the fingers.

(2) When however the eggs have hatched and the young caterpillars are feeding they should be swept up with a hand-net (Text Fig. 22). The caterpillars should be kept in a vessel of water to which a little kerosene oil has been added.

(3) When the caterpillars have grown and have almost eaten away the plants, which they do if not observed earlier, it is certain that they will now move on to other fields. In order to prevent them from doing so, it is necessary to dig a trench all round the infested field.

The trench can be filled with water if available. In trying to move to other fields the caterpillars will fall in the trench and get drowned or if there be no water they can be covered with earth. At the same time as many as possible should be swept up with the hand net.

(4) If the infested seed-bed can be flooded it has a good effect. After filling the seed-bed with water the plants should be shaken by drawing a rope across them. The caterpillars are thus drowned. If any float, they can be swept up with the hand net.

(5) If available ducks and fowls can be turned out in the seed-bed to pick up the caterpillars. Many kinds of birds, such as crows and mynahs (*sa-yet*) eat these caterpillars. Therefore branches of trees or bushes can be provided in the field to serve as perches for these birds which can be further attracted by rice being thrown in the fields and embankments. The work of ridding the fields of the caterpillars should not however be left to the birds alone.

As soon as the pest is noticed it should be promptly and vigorously tackled by any or all of the above means.

THE RICE STEM GALL FLY.

(*Pachytiplosis oryzae* Wood-Mason.)

VERNACULAR AND LOCAL NAMES.—*Kyet-thun-meik* ; *kyet-thun-fo*, i.e., onion shoot insect.

Plate 15.

The stem of young paddy plants instead of growing normally is converted into a hollow long gall which on account of its resemblance to an onion shoot is popularly called *kyet-thun-meik* or onion shoot disease (Fig. 1). The formation of the gall is due to irritation caused by a minute maggot (Figs. 2 and 4) feeding inside the growing point of the stem. The maggot when fullgrown turns into a pupa (Figs. 5, 6 and 7 back, front and side views) and when the gnat or fly (Figs. 8 and 9) is about to emerge the pupa wriggles up the hollow gall and bores a hole of exit for the gnat at its upper end. The long hollow gall which grows much higher than the level of water in the field is a safe outlet for the gnat. The maggots hatch out of eggs (Fig. 3, much enlarged) laid by the gnats, which infest young plants, rarely in the seed bed but more often amongst newly transplanted or broadcast plants about September-October. The plant of which the stem is thus converted into a gall ceases to grow but is capable of giving rise to tillers.

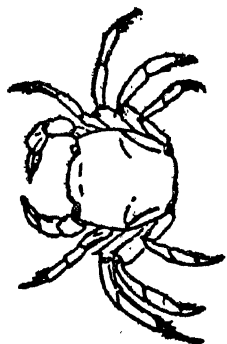
The gnat is very small, so that when and how it will infect the plants can not be known. There is no means of preventing infestation. But by irrigation and manuring the infested plants can be stimulated to grow tillers which generally yield a normal crop. This method should be followed wherever *kyet-thun-meik* appears.



Rice Stem Gall Fly
(*Pachydiplosis oryzae*)

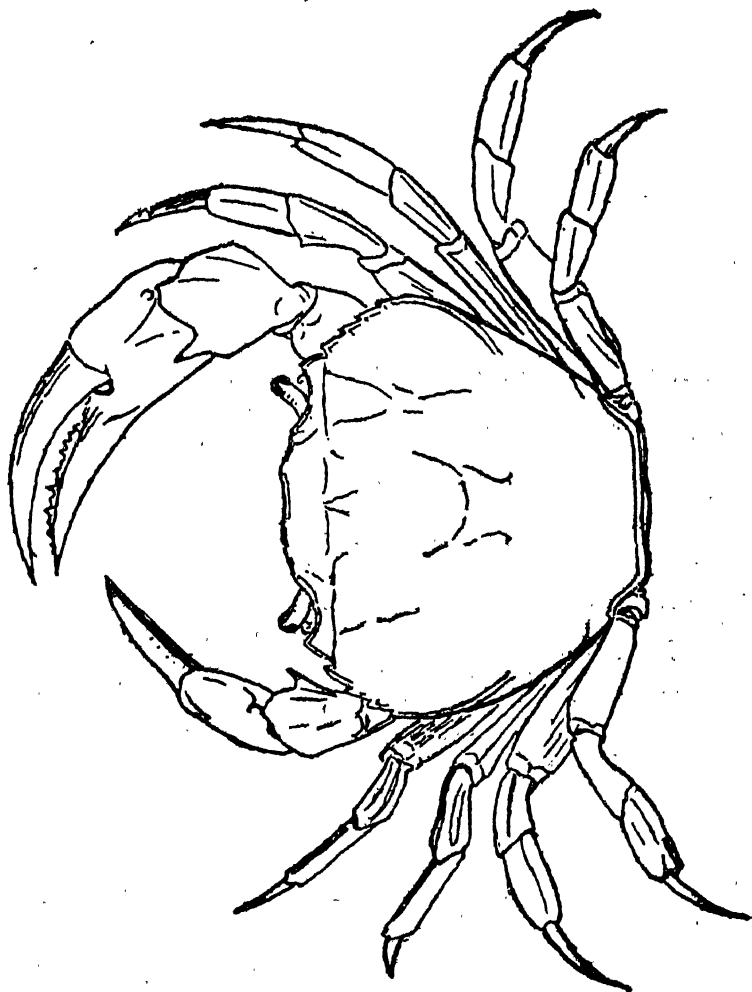
CRABS.

(*Varuna litterata* F., quasi-sea crab and *Potamon dayanum* W.-M., land crab.)



2 1

Hpaung-si-ganan



2

Le-bazun-lon

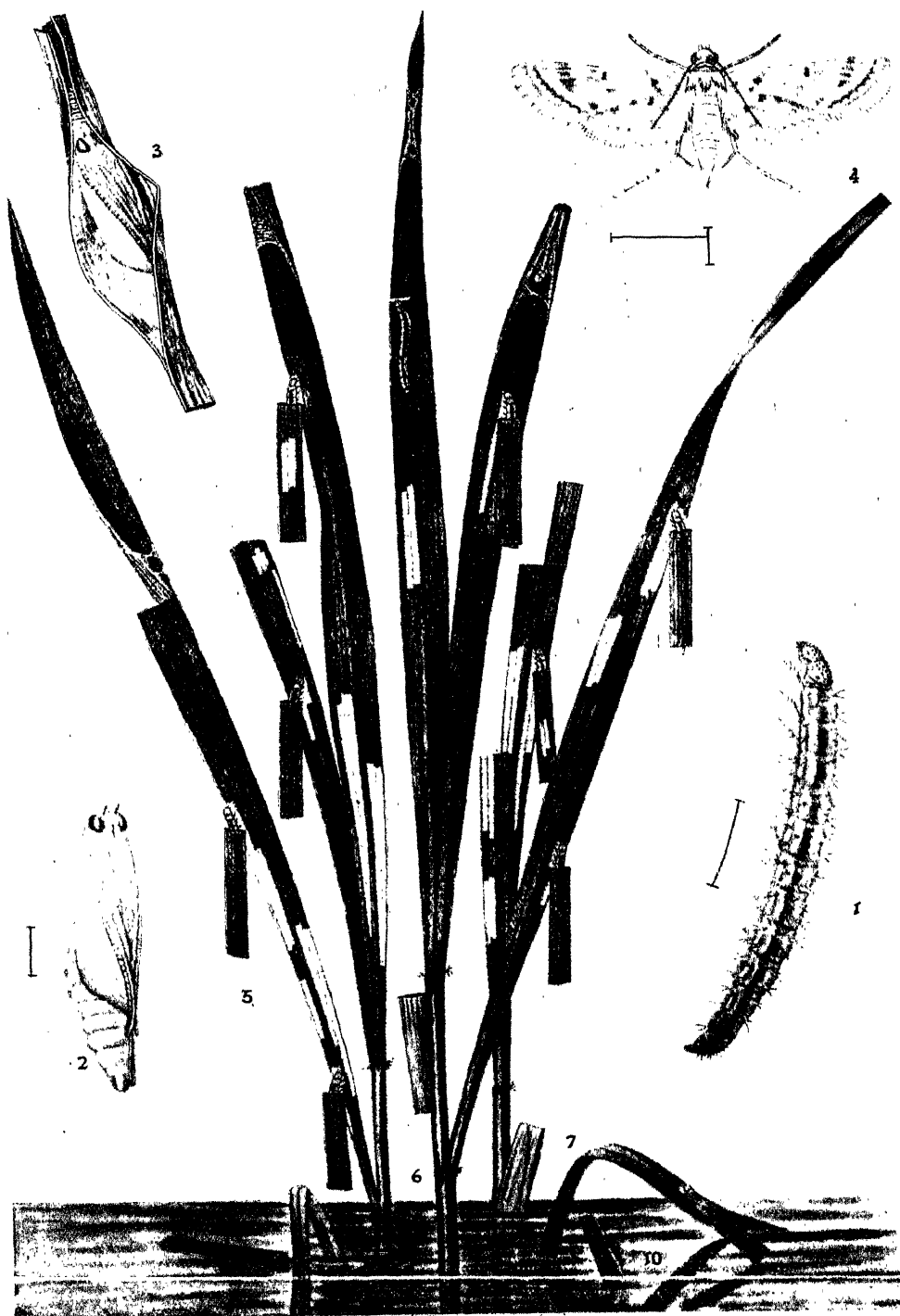
Text. Fig. 32.

CRABS AMAGING RICE P. NT.

Broadly speaking two kinds of crabs occur in the paddy fields in Burma, *viz.*, quasi-sea crabs and land crabs.

As far as is known the quasi-sea crabs commonly called *hpaung-si-ganan* (literally raft riding crabs on account of their habit of mounting on floating logs, etc., while moving with the tidal water) occur in all the sea-coast districts in Lower Burma, especially in Amherst, Thaton, Hanthawaddy and Myaungmya. The adult crabs are small flat creatures, the body being about the size of the thumb nail. They go down to the sea with the tidal water in *Waso-lasan* (early part of July) and never return. They breed in the sea. The young crabs come up to the fields in *Wagaung-la-byi-gyaw* (latter part of August) and live in the fields till *Waso* next year when being fullgrown they in their turn move down to the sea. The dates of these annual migrations vary a little from place to place and are known to the local cultivators. Germinated paddy seeds are broadcast after the departure of the adult crabs and the plants grow sufficiently by the time the young crabs come up. Therefore hardly any damage takes place. The adult crabs nip the young shoots if the seeds are sown before they depart. The only complaint at present against these crabs is that owing to their presence, sowing cannot be undertaken early. The present practice, however, seems to be the best. These crabs occur in such numbers that while they migrate they cover the entire surface of land and water. Attempts at fighting them over miles and miles of paddy fields will be expensive and probably fruitless.

Land crabs (*le-bazun-lon*) occur on high lands throughout Burma both in the plains and hills. They are common especially in the fields which are cultivated under irrigation. Young ones are given birth to (about 650 by each female on the average) about June to August and are carried very easily by the irrigation water which therefore helps them to spread. They continue to live in the fields and take about three or four years to become fullgrown. They come up to the surface in the rains, going underground and resting there during the other seasons. They are known to go down to a depth of as much as 12 feet. They occur in very large numbers, an idea of which may be formed from the fact that more than 20,000 were caught in a field of about 16 acres in area in the Mandalay Farm in the course of about two months in earthen traps described below but still many more were left in the field. They are mainly carnivorous and carrion feeders living on small creatures or dead animal matter, but they also cut paddy seedlings and eat small portions of the plants. If they had to depend on paddy seedlings alone for food, growing of paddy would have been impossible over vast areas in the province.



RICE CASE WORM.

In paddy fields they cause trouble in two ways, *viz.*, by boring holes in the embankments (*kazins*) and thus allowing the water to percolate and by nipping young transplants which require to be replaced, thus involving additional expense and delay in the growth of the crop.

The simplest way which is within the means of all to deal with these crabs is to catch them in ordinary wide-mouthed earthen pots sunk in the fields and water channels and baited with fried *hnan-bat* (oil cake) and *phwe-nu* (fine bran obtained in milling rice). Up to 43 crabs have been trapped in a single such pot in a single night. Cutting of paddy seedlings was soon stopped by setting up such traps.

The pot should be sunk low in the ground and earth placed round its mouth so that crabs may easily crawl in. The mouth should be below water and about level with the soil. The oil cake and *phwe-nu* are fried over a fire, the oil cake pounded and both mixed and made into small balls with a little water of about the size of a pigeon's egg. A ball is placed inside the pot. The trapped crabs should be collected every morning and the bait laid in the evening. About five traps are required for each acre of land.

THE RICE CASE-WORM.

(*Nymphula depunctalis* Gn.)

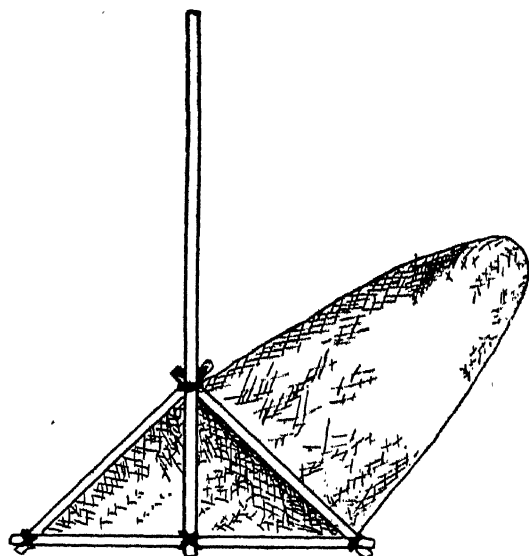
VERNACULAR AND LOCAL NAMES.—*Kama-kalaukana* and *kama-hamaung* (Tenasserim-Talaing) ; *Monhaw-phin* (Southern Shan States—Shan) ; *Paung-gok-paw-kare* (Tenasserim—Karen) ; *Saba-ywet-leik-fo*, *i.e.*, paddy leaf roller (Akyab) ; *Thee-moo-paw* (Toungoo—Karen) ; *Ywet-leik-fo* and *Ywet-pyat-fo* (Akyab, Katha, Tavoy, Minbu, Allanmyo etc.) ; *Ywet-pyat-daung-de* (Akyab).

Plate 16.

This pest infests young plants in seed beds and in broadcast and newly transplanted fields. It is called *ywet-hpyat-fo* because the caterpillar (Fig. 1) cuts across leaves. Small tubes or cases are made with cut bits of green leaves and the caterpillars live inside these tubes which are found floating on the surface of the water in infested fields (Figs. 8 and 10). The caterpillars crawl up the plants carrying these tubes with them and nibble the green tissue of the leaves which dry and turn yellow. Entire seed beds and transplanted or broadcast fields may dry and become yellow in this manner. The plants, however, are not killed outright and revive later, though their growth is retarded to a great extent and the yield is diminished.

Unlike most insects these caterpillars have to keep their bodies wet in order to be able to breathe. The tubular leaf cases in which they live are of help for this purpose. After feeding for some time the caterpillars let go their hold and drop on the water and swim on to other plants, thus replenishing the moisture inside the tubes. Fresh cases are made when the old ones begin to decay.

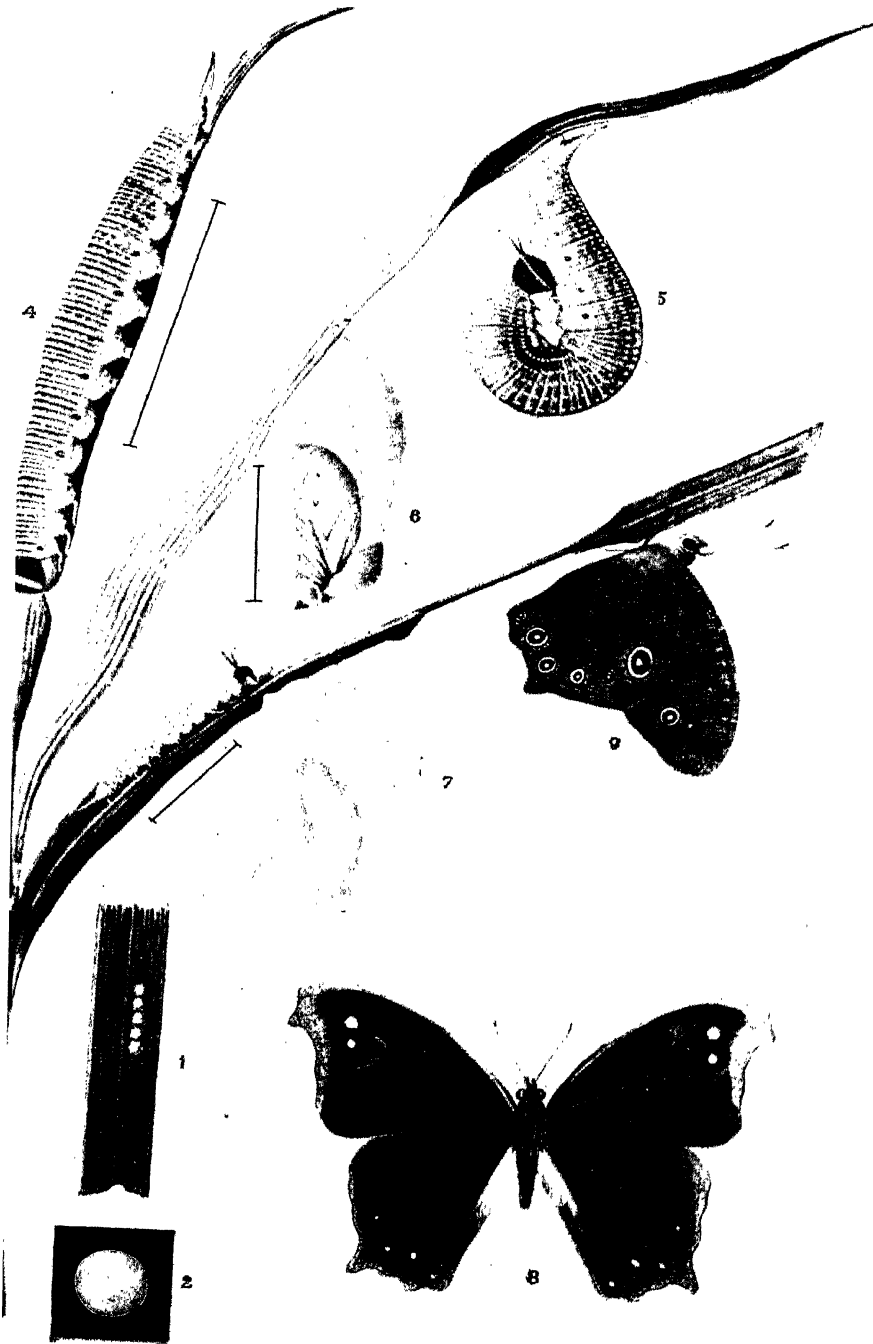
The caterpillars live and feed in this manner for about two weeks and then fasten the cases usually on the stem (Figs. 6 and 7) and pupate inside them (Figs. 2 and 3, the case is detached from the stem and the pupa is seen inside and enlarged). In about a week a small white-coloured moth with black and yellow markings on the wing (Fig. 4) emerges from the pupa. These moths are found flying in paddy fields. They deposit eggs on the leaves and from these eggs the caterpillars hatch. The eggs are tiny specks hardly visible to the naked eye.



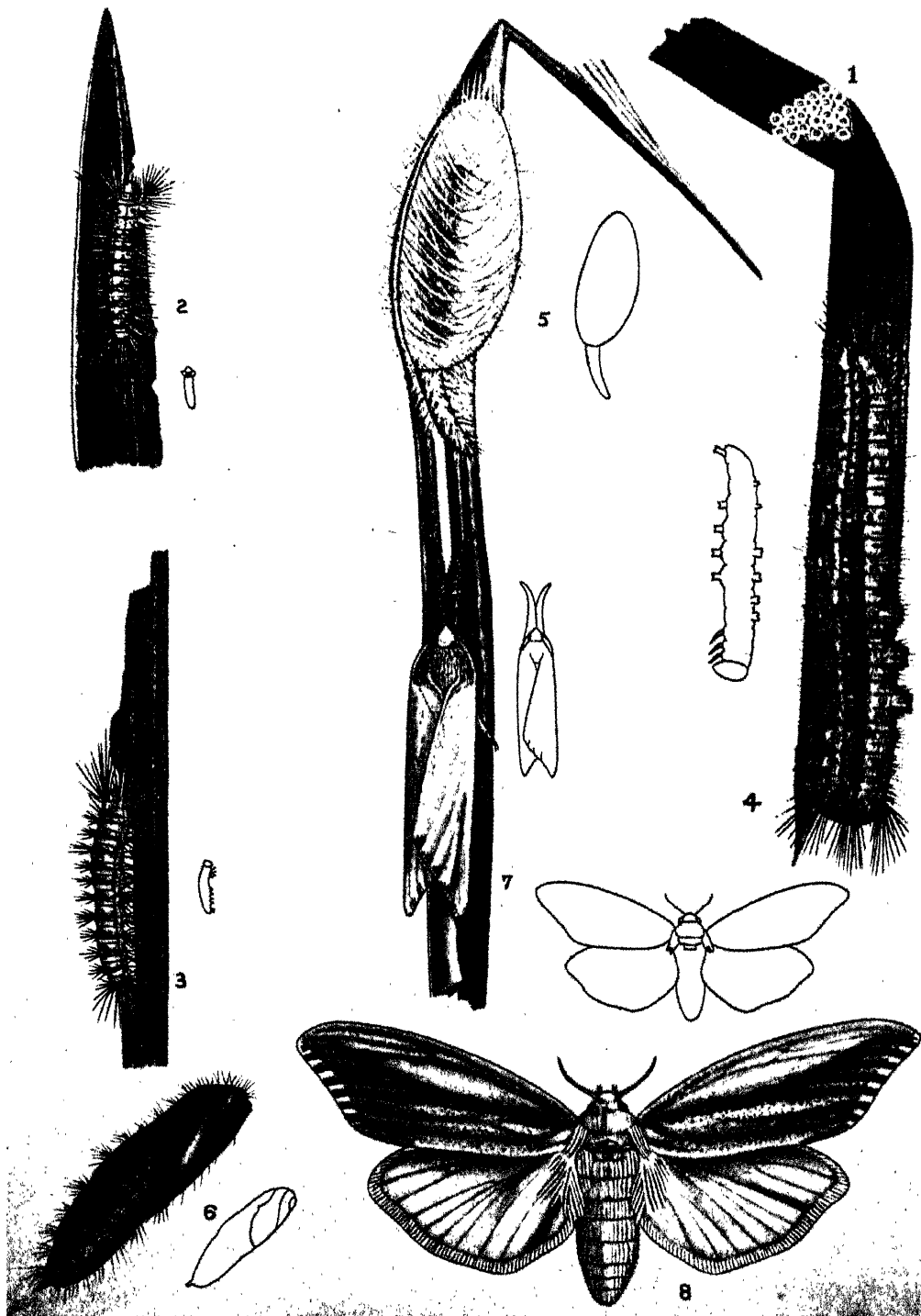
Text Fig. 33.

TRIANGULAR HAND NET.

The simplest remedy is to sweep up the cases as soon as they appear with a triangular hand-net (Text Fig. 33). The net is drawn with one edge just under the surface of the water. The work can also be easily done with a thin cloth held by two persons at opposite ends and drawn with one edge under the surface of the water. It is only necessary to throw the collected cases on dry land. The caterpillars die when their body dries up.



Rice Leaf Butterfly
(*Melanditis ismene*)



DASYCHIRA SECURIS.
Rice Hairy Caterpillar.

THE RICE LEAF BUTTERFLY.

(Melanitis ismene Cram.)

VERNACULAR AND LOCAL NAMES.—*Mon-cho-lon* (Southern Shan States, —*Shan*) ; *Say-cho-tan* (Southern Shan States—*Taungthu*) ; *Wong-chio-lai* (Karenni and Southern Shan States—*Shan*) ; for unidentified leaf-eating caterpillars on paddy—*Daungde* (Henzada Bassein, Lower Chindwin, Akyab, Minbu, Tavoy and Mergui) ; *Hpok-kyaik* (Katha—*Kadu*) ; *Kachen-ren* (Ruby Mines—*Kachin*) ; *Pek-kya-ik* (Katha—*Kadu*) ; *Sab-ywet-pyat-po* ; *Say-am-bu-la* (Southern Shan States—*Taungthu*) ; *Sa-kauk* (Katha—*Shan*) ; *Sal-rit-hnik* (Chin Hills—*Chin*) ; *Shin-kyen-ren* (Bhamo—*Kachin*) ; *Tin-gyam* and *Tin-yawp* ; (Ruby Mines—*Kachin*) ; *Tung-teow* (Chin Hills—*Chin*) ; *Ywet-pyat-po* (Kyaukse).

Plate 17.

This caterpillar is frequently found eating rice leaves but rarely occurs in large numbers. It causes some damage, no doubt, but even at its worst it can be considered to be of only minor importance. Cultivators see it easily and therefore frequently get alarmed and ascribe to it various other ailments from which the plants may be suffering at the time.

Butterflies (Figs. 8 in flying and 9 in sitting posture) lay round pearly eggs on leaves (Fig. 1 ; Fig. 2 shows one egg enlarged). Caterpillars hatching from these eggs in about four days eat the leaves, grow, (Figs. 3—4) and when fullgrown, in the course of about three weeks, prepare for pupation by attaching the hindmost legs to some silken filaments previously applied on a leaf and hang head downwards in a doubled up posture (Fig. 5). The larval skin is then shed and the pupa or chrysalis (Fig. 6) appears. In the course of about a week and a half the butterfly develops inside the pupa and issues by bursting open the pupal skin (Fig. 7). The simplest measure is to pick off the caterpillars by hand.

THE RICE HAIRY CATERPILLAR.

(Dasychira securis Hb.)

VERNACULAR AND LOCAL NAMES.—*Kama-hnut* (Tenasserim—*Talaing*) ; *Khu* or *Khugaung* (Shwebo, Katha) ; *Mon-nan-nine* (Southern Shan States—*Shan*) ; *Po-hmwe-zok*, i.e., hairy insects (Pakôkku) ; *Say-taung-phin* (Southern Shan States—*Taungthu*).

Plate 18.

As regards damage to paddy plants the same remarks are applicable as made under the rice leaf butterfly above.

Eggs are laid on the leaf in a cluster (Fig. 1). The caterpillars hatching from these eggs in about five days eat the leaf and grow during

the course of about 15 to 20 days (Figs. 2—4 in different ages). The fullgrown caterpillar forms a cocoon (Fig. 5) on the leaf with silk exuded from the mouth and the hairs of the body ; it then pupates. The pupa (Fig. 6) is also hairy. The moth (Figs. 7 in sitting and 8 in flying posture) develops inside the pupa and emerges in about seven days by bursting open the pupal skin and making a hole at one end of the cocoon. The moths are sluggish and do not fly much.

The simplest remedy is to pick off the caterpillars by hand.

THE RICE LEAF BINDING CATERPILLAR.

(*Parnara mathias* Fb.)

VERNACULAR AND LOCAL NAMES—*Hpet-leik-po* (Mergui) ; *Myin-mum-lon* (Southern Shan States—*Shan*) ; *Pit-htu-tan* (Southern Shan States—*Taungthu*) ; *Po-kala*, *Po-kyā*, *Po-sein-kyā*, i.e., striped insect (Meiktila, Upper Chindwin).

Plate 19.

As regards damage to paddy the same remarks as for the leaf butterfly and hairy caterpillar are applicable.

The caterpillars (Figs. 2 and 3) have the habit of binding and folding leaves and feeding while living in the folds. When fullgrown, in the course of about 20 days from the time of hatching from eggs, they transform into pupae (Fig. 4) inside the folds and after about 7 to 9 days issue as butterflies (Figs. 5 and 6 in sitting and 7 in flying posture). The butterflies lay eggs (Fig. 1 enlarged) from which caterpillars hatch in about 3 to 4 days.

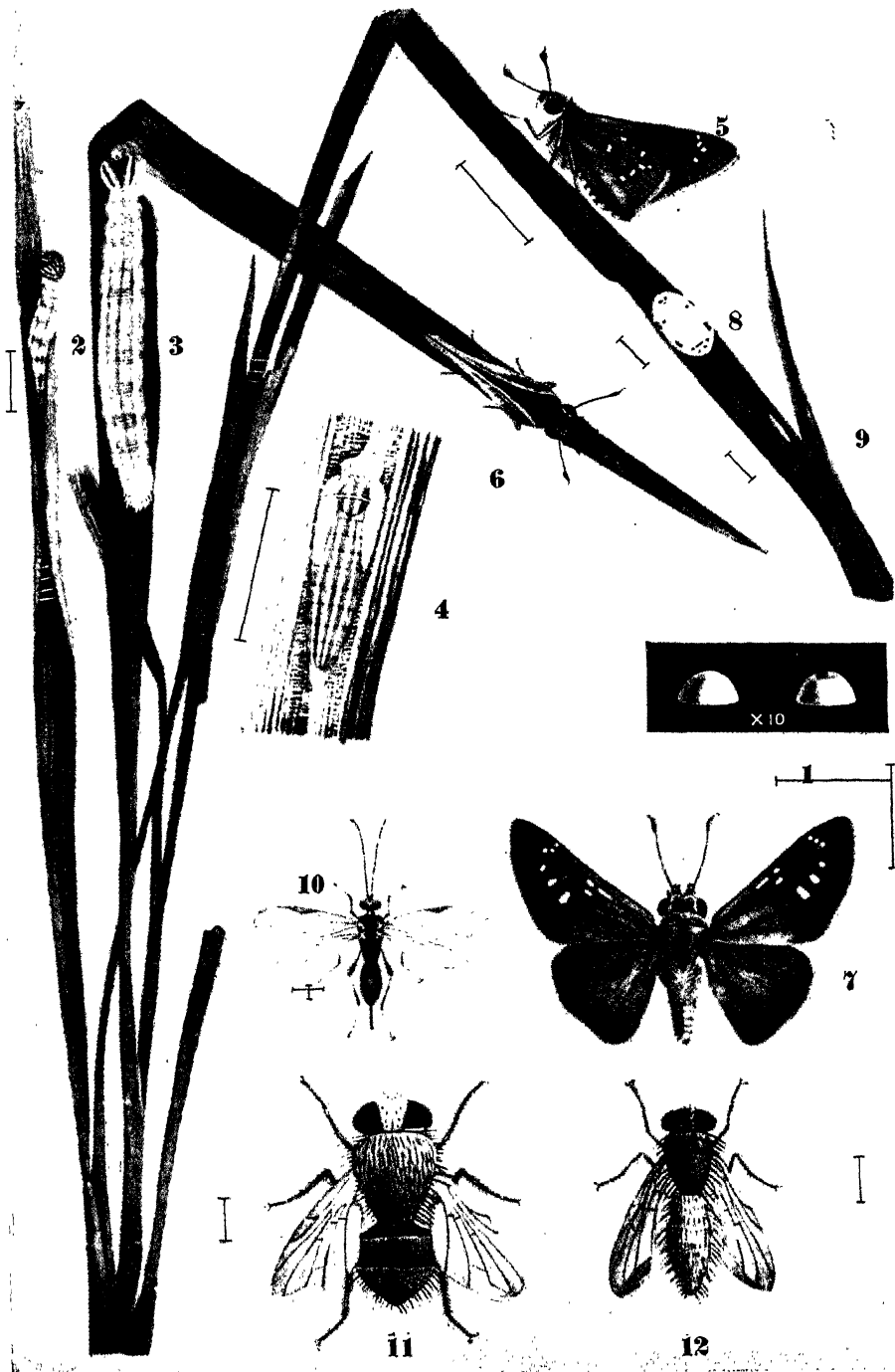
Hardly any control measure is necessary. The caterpillars can be picked off if occurring in numbers.

Figures 8 and 9 in the plate are pupae of flies (Figs. 11 and 12) which are parasitic on the caterpillar. Figure 10 shows a small wasp which is also parasitic on the caterpillar.

THE RICE HISPA.

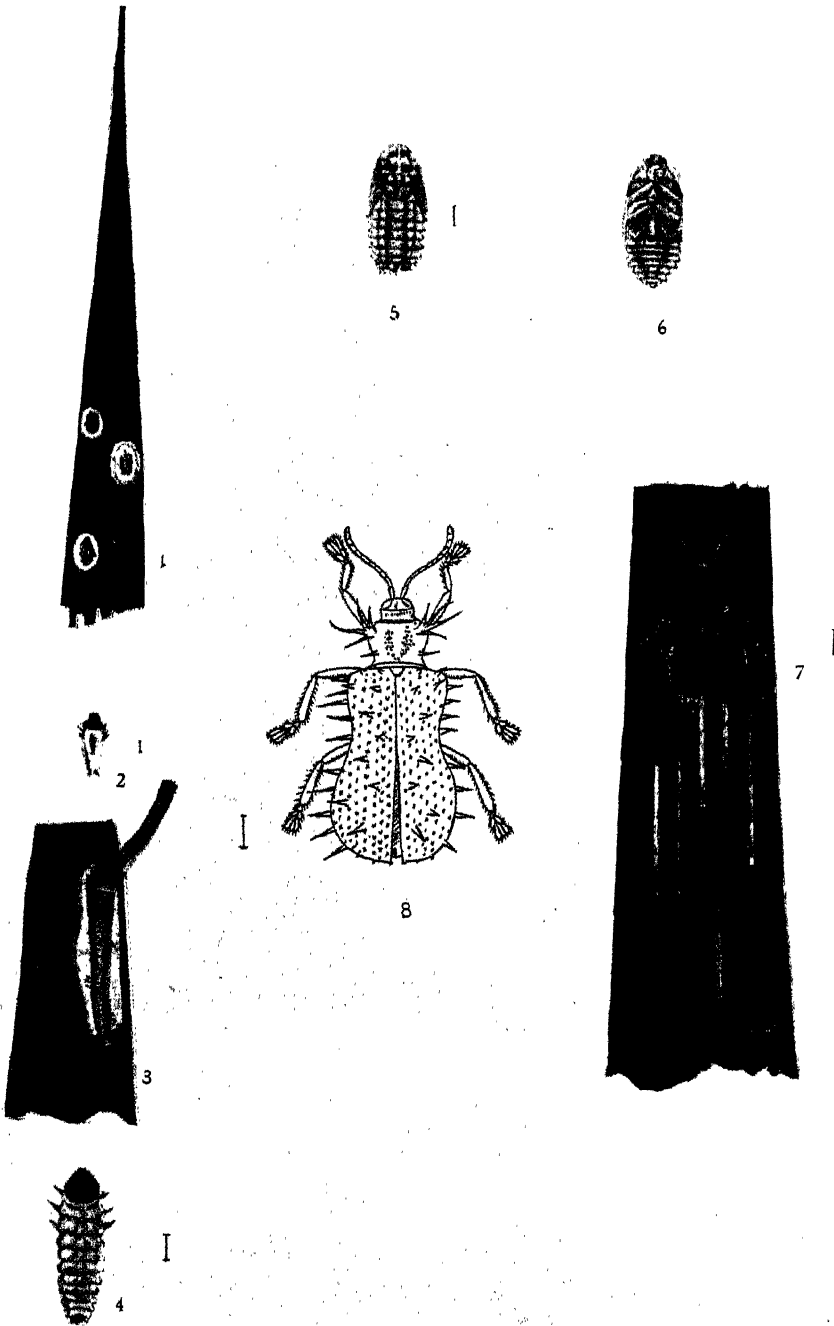
(*Hispa armigera* 01.)

VERNACULAR AND LOCAL NAMES.—*Aung-gaung* * (Katha—*Kadu*) ; *Chying-ma* (Myitkyina—*Kachin*) ; *Gaung-pyu-po*, i.e., white top pest (Shwebo) ; *Gi-mu*, i.e., fire pest (Tenasserim—*Karen*) *Hpalan-po* (Shwebo) ; *Kama-karin* (Tenasserim—*Talaing*) ; *Kyil* (Bhamo—*Shan*) ; *Laung-mi-po*, i.e., scorching pest (Tavoy) ; *Maik-mein*, *Maing-paung-paing* (Katha—*Shan*) ; *Make* (Katha—*Kadu*) ; *Mon-kyin-mine* (Southern Shan States—*Shan*) ; *Nyun-pru*, i.e., white tip (Akyab—*Arakanese*) ; *Po-hpalan* or *Po-laung-mi* or *Po-laung-po* ; *Po-khum-khet*, i.e., thorny shelled insect (Pakôkku) ; *Saba-ywet-shree-sa-po*, i.e., insect eating epidermis of paddy leaf or *Saba-ywet-po*, i.e., paddy leaf pest (Akyab, Kyaukpyu and Sandoway).



Rice Leaf-binding caterpillar
(*Parnara Mathias*)

PLATE 20



RICE HISPA.

Plate 20.

This pest appears as small steel-blue-coloured shiny flat beetles with spines on the back (Figs. 7 and 8). The beetles feed by nibbling the green tissue of the leaves producing narrow longitudinal whitish streaks (Fig. 7). When many beetles feed in this manner, the leaves are stripped practically wholly of green tissue and become dry.

The pest injures the plants in another way. The beetles thrust small eggs inside the leaf tissue, usually at the upper part of the leaf (Fig. 1). The young grubs which hatch from these eggs in 4 to 5 days corrode the leaf between its two surfaces producing yellowish white blotches. As several eggs are deposited on the same leaf, the entire leaf may be corroded in this manner and then it dries and turns yellow (Fig. 3). Whole fields may look dry and yellow.

When an infested leaf is held against the light the small flattened black headed yellow grubs (Figs. 2 and 4) are visible or they may be felt by passing the leaf between the fingers. After feeding for about a week the grubs change into pupae (Figs. 5 and 6) inside the corroded leaf and ultimately come out as beetles (Fig. 7) in the course of about 4 or 5 days more. The whole life-period from the time eggs are laid to the time of emergence as perfect beetles does not take more than about two weeks. The new beetles start laying eggs. Therefore their number increases rapidly.

A few beetles occurring in a scattered manner as they do generally in Upper Burma are not capable of doing any appreciable damage. In some of the sea coast districts in Lower Burma, however, they occur in swarms and some damage is done where the swarms settle. In Upper Burma districts too swarms occur occasionally in some places and in some years.

The beetles normally feed and breed on wild grasses. They appear on paddy usually about July. As breeding takes place on the paddy their number increases and they spread. The beetles may continue to do damage till about September or October when they leave the paddy.

As a result of their feeding and breeding in the manner described above the upper parts of the leaves of the plants in entire plots or in large patches in the midst of extensive fields may dry and become yellow. The plants are, however, seldom killed outright. When the leaves dry all beetles move to other fields and the plants throw out fresh shoots, grow and bear. But their yield is diminished and the loss in the worst cases may be as much as fifty per cent.

The simplest and best remedy is to keep watch on fields and as soon as the beetles come and settle they should be swept up with a hand net. The net should be held in both hands and swung from

right to left and left to right so as to brush the plants. A space of about five feet can be cleared in this manner and the man walking up and down the field can sweep up the swarm in a very short time. This should be done on clear days when the plants are dry. The net also should be kept dry. The beetles which are caught in the net should be emptied into a kerosene tin or earthen vessel containing water to which a little kerosene oil has been added and left therein. If the cultivators follow this method hardly any damage will be done to their fields.

If eggs have already been laid on the leaves, this will soon be evident from the appearance of yellow blotches due to the corroding of the grubs, the tops of the leaves should be cut off with a sickle and burned or buried. This will prevent the birth of fresh beetles in the fields. The plants are hardly affected by this operation.

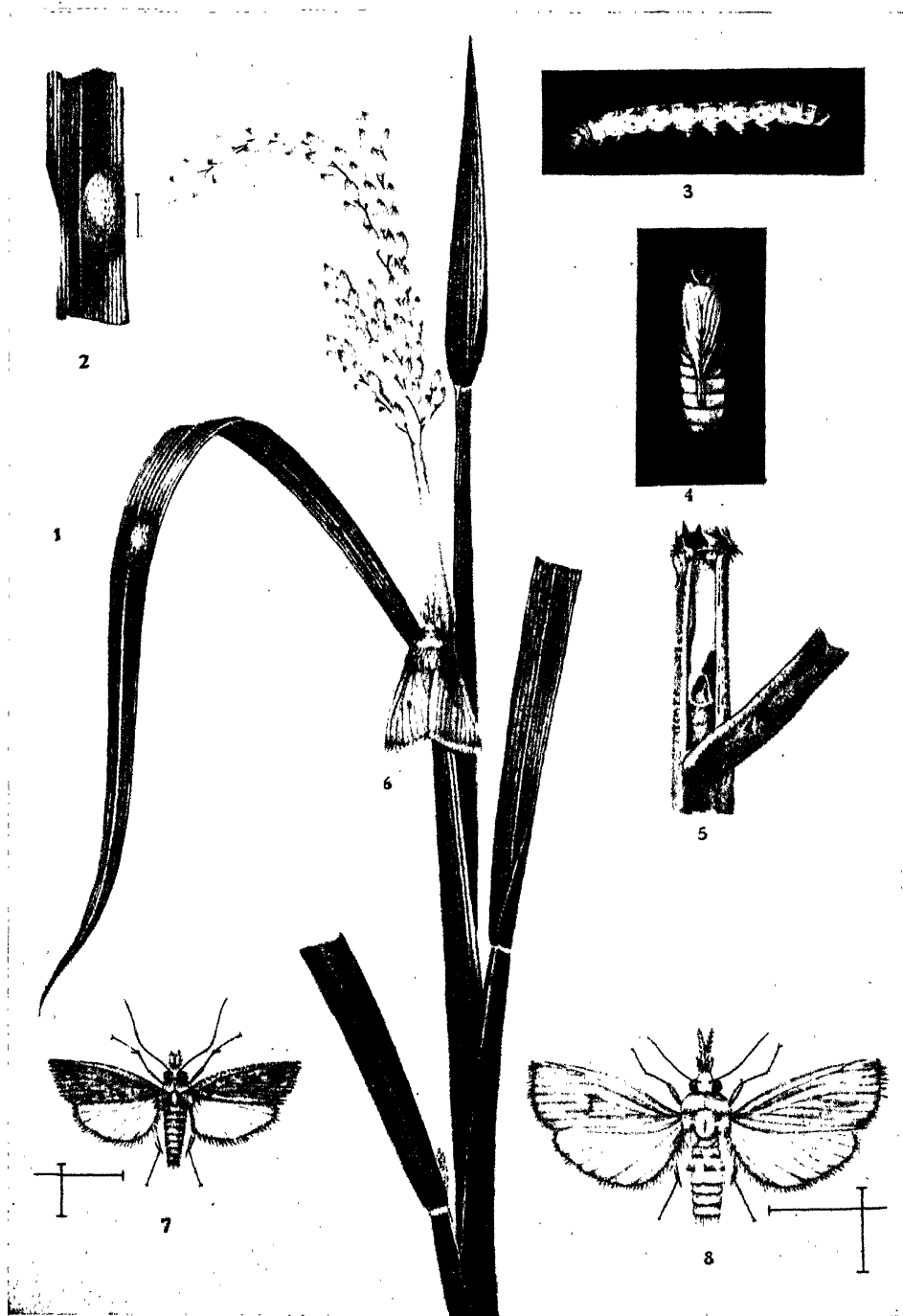
THE RICE STEM BORERS.

(*Schoenobius bipunctifer* Wlk.)

VERNACULAR AND LOCAL NAMES.—*Asit-po*, i.e., joint worm ; *Boo-akha*, i.e., paddy pest (Toungoo—Sgaw Karen) ; *Dingyam* (Bhamo—Kachin) ; *Go-po*, i.e., neck pest (Pegu, Bassein, Thayetmyo, Minbu, Southern Shan States) *Hnan-pyu-po*, i.e., white ear pest ; *Hpalamubwe* (Leiktho—Karen) ; *Kadon* (Katha—Kadu) ; *Kama-Karud* or *Kama-Tang* (Tenasserim—Talaing) ; *Leikpya* on *mayin* paddy (Minbu) *Mon* (Katha—Shan) ; *Mon-ton-ta* (Southern Shan States—Shan) ; *Mying-se-li* (Bhamo—Shan) ; *Ooshauk-po*, i.e., going through the core—(Arakan) ; *Saba-hnan-pyu* (Akyab) ; *Pukha-aung* (Amherst—Karen) ; *Runbo* (Akyab—Arakanese) ; *Saba-run-po*, i.e., paddy base cutting pest or *Saba-u-po*, i.e., paddy heart pest (Kyaukpyu and Sandoway) ; *Sat-mee*, i.e., sambhur tail (Hanthawaddy) ; *Sh-i-eache-ku* (Karenni) ; *Sit-po* ; *Tagun-po* (Katha, Shwebo) ; *Ting-soi* (Ruby Mines—Kachin) ; *Wong-puk-ho-lam* (Southern Shan States and Karenni—Shan).

Plate 21.

Sitpo (literally meaning joint-worm) is a caterpillar (Fig. 3) which bores inside the stem. When it is full-grown it transforms into a pupa (Fig. 4) and sleeps for several days. From the pupa the moth emerges (Figs. 6 female in sitting and 7 male and 8 female in flying posture). This moth is called *leikpya* in some places. The moth lays eggs in clusters on the leaf or stem and covers them with brown hairs so that the egg-clusters look like small heaps of hairs (Figs. 1 and 2). Each female moth lays about 300 to 400 eggs. The eggs are small and on the average about two hundred of them are contained in individual clusters. From these eggs the stem borer caterpillars hatch, spread to



RICE STEM BORER.
(SHÆNOBIUS.)

different plants, and feed by boring inside the stem. They grow and in their turn develop into moths. The life-cycle occupies about a month-and-a-half. But in the cold weather most of the caterpillars rest in the stubble and do not transform into pupae and emerge as moths until it gets warm about March.

The external symptom of the attack is the drying of the central heart leaf in young plants and of the ear in the mature plants. The ears turn white and no grains are formed. The outer leaves may remain green and usually there is no discolouration of any other part of the plant. A plant here and a plant there show white ears in this manner. The damage in this form is therefore very little. The reason is that paddy is grown over extensive areas and the *sit-po* finds unlimited food and is scattered in such a manner that hardly much damage is done in any particular field.

The only place so far known where *sit-po* causes real damage is Paunglin in Minbu District. All over the country surrounding Paunglin, *kaukkyi* paddy is grown between July and January. During the hot weather *mayin* paddy is grown round the lake at Paunglin, there being no other paddy at this time for miles all round. The *sit-po* worms resting in *kyaukkyi* stubble in winter issue out as *leikpyas* when it gets warm in March and swarm on this *mayin* paddy, literally covering the plants with egg-clusters. Therefore very severe damage is done. This damage has however been stopped by the introduction of a short-lived paddy which is sown at the end of March. The plants escape the *leikpyas*.

Sit-po is very commonly confused with diseases known in different places as *gwabo*, or *gwinna*, or by other names. These diseases are not caused by insects. *Sit-po* worms may occur in such plants or fields, but should not be taken to be the cause of the disease.

Under ordinary conditions therefore *sit-po* cannot be considered to be a serious pest of rice. Still in order not to allow it to increase in number it is advisable to follow the only two effective and practical remedial as well as preventive measures, *viz* :—

(1) Ploughing up the stubble as soon after the harvest as practicable and burning it with the caterpillars in it. In most parts of Burma however the stubble is left in the fields to be used as fodder. And although burning is practised in most cases it is done at a time when the moths have emerged.

(2) Pulling up the plants with the white ears and burning them. This should be done as soon as the ears are noticed to be turning white. At this time a number of young caterpillars (up to 70 or more), the majority of those which hatch from the egg-cluster, are present in each of these plants. If this is practised as a routine for every crop of rice

there will be very few *sit-po* in the succeeding crops. The affected plants are easily noticed and as not many occur, the work is very easily done without involving much time.

In cases of damage as at Paunglin special measures are necessary, if damage cannot be evaded as has been done there. If the *kaukkyi* stubble is ploughed up and burnt in February, no *leikpyas* can hatch. This is, however, hardly practicable. The best thing is to collect the *leikpyas* with hand nets every night and destroy the egg-clusters either by plucking off and burning them or by crushing them between the fingers.

N.B.—The stem borer of which the life-history is given is *Schoenobius bipunctifer* which is of universal occurrence and is a persistent pest on rice. Along with it the following two also occur occasionally, viz., *Chilo oryzae* Fl. whose caterpillars are faintly striped and the Pink Shoot Borer of cane, *Sesamia inferens* (Plate No. 28) whose caterpillars are flesh coloured. All the three may occasionally occur in large numbers when the paddy is putting forth ears. The external symptom of attack is similar in all cases.

In India a fourth stem borer *Chilo simplex* Butl. (or *zonellus* Swinh.) is known to occur which is more injurious than all the above three and is, further, a serious pest on *pyaung* (Andropogon) and should be guarded against. It may travel in *pyaung* and sugarcane stems and precautions should be taken against its entry into Burma.

THE RICE JASSIDS OR LEAF HOPPERS.

(*Nephotettix bipunctatus* Fb.)

Plate 22.

This small green bug which sometimes comes to lights in swarms in early winter especially about the time of the *dewali* festival, sometimes occurs on rice in large numbers. It breeds on the rice and as both young and adult ones suck the juice of the plants very serious damage may be done. It occurs in pest form only rarely.

Figs. 5 and 6 show male and female adults enlarged about 15 times. The female deposits eggs in slits made in the leaf tissue (Fig. 2 eggs exposed and Fig. 3 one egg separately all enlarged about 14 times). Nymphs (Fig. 4 very much enlarged about 72 times) hatching out of the eggs in about four days feed and grow, gradually developing wings and attaining the adult state in the course of about 12 to 16 days, when the wings are fully developed. Fig. 1 shows a rice plant with the nymphs and adults sitting on it. The bug has the habit of jumping or hopping off on disturbance.

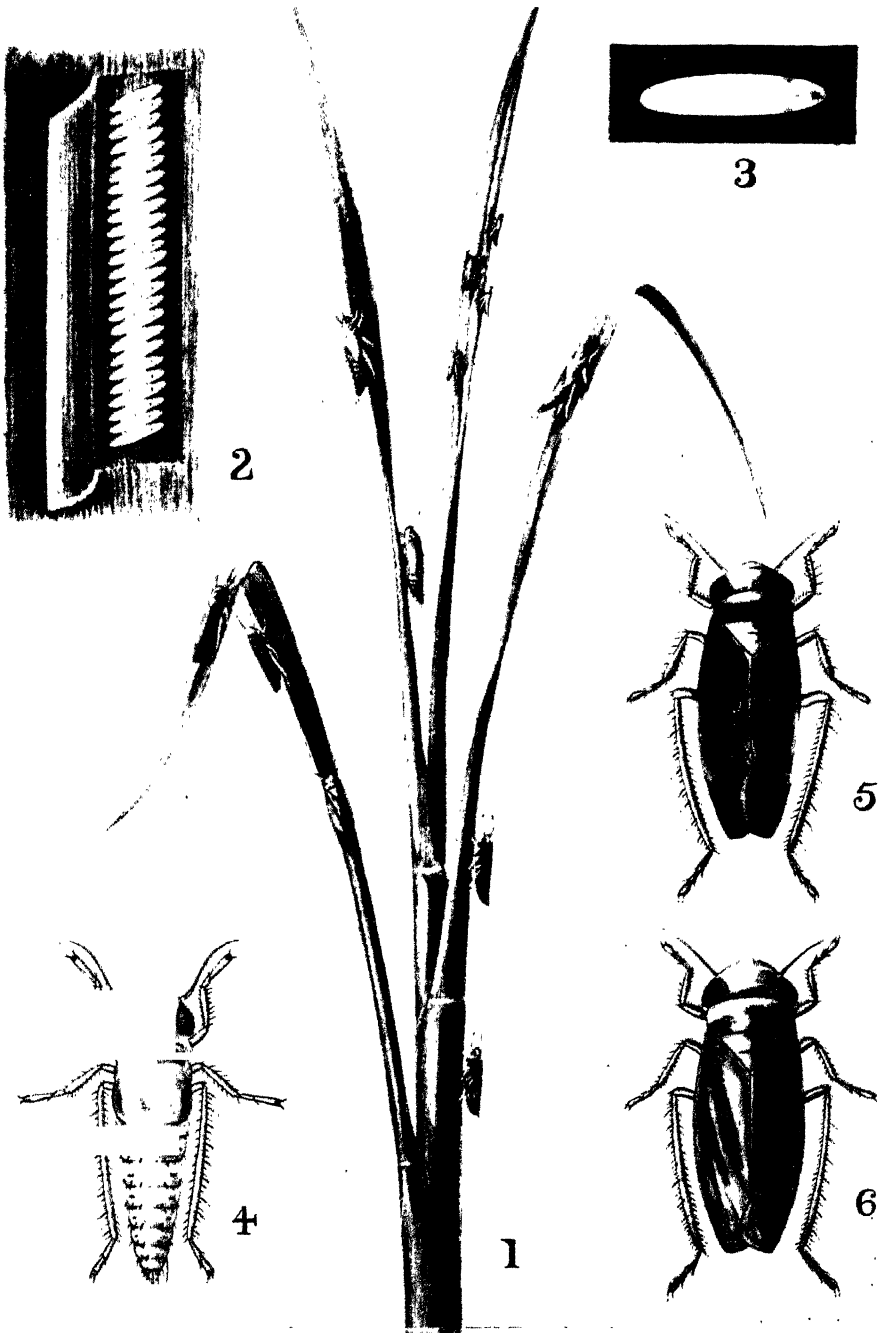
When the insects appear in pest form they are best swept up with hand nets. Light traps can also be used.

THE RICE STEM MEALY BUG.

(*Ripersia sacchari oryzae* Gr.)

Plate 11—Figs. 1-2.

As the bugs live in hidden situations under leaf sheaths their presence is not detected unless a diseased or unhealthy condition of the



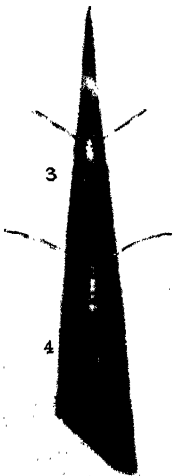
Rice Leaf Hoppers
(*Nephotettix bipunctatus*)



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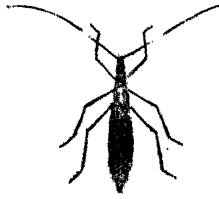


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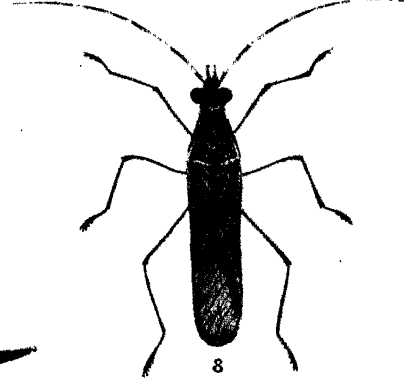
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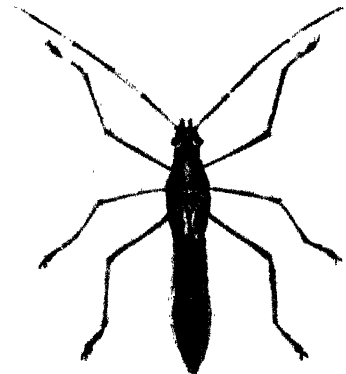
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7

RICE BUG.

plants attracts attention. The bug when occurring in numbers causes stunted growth and even death of the infested plants. When, however, one or two bugs are present in plants which show a general unhealthiness the cause of the diseased condition should be looked for elsewhere. The bug has not been observed to occur widely and individual clumps infested by it should be up-rooted and burnt so as to remove sources of infection to surrounding plants. (See Mealy Bugs, page 44).

THE RICE EAR BUG.

(*Leptocorisa varicornis* Fb.)

VERNACULAR AND LOCAL NAMES.—*Hnan-pyu-fo*, i.e., white ear pest (Arakan, Tavoy); *Kama-Patha* and *Kama-Karaung* (Tenasserim—*Talaing*); *Mon-myin* (Southern Shan States—*Shan*); *Po-nan*, i.e., bad smelling insect (Minbu); *Say-nwum-sein* (Southern Shan States—*Taungthu*); *Thraw* (Toungoo-Karen); *Thunt* (Tenasserim—*Karen*).

Plate 23.

This bug appears when the ears are forming milk and sucks out the milk leaving the grains empty. It emits a strong buggish smell.

The adult bug (Fig. 8) which can fly, comes and deposits eggs on the leaf (Fig. 1, Fig. 2 shows one egg enlarged from a side). The young nymphs hatching out of these eggs in the course of about a week feed by sucking milk in the same manner as the adults and grow, gradually developing wings (Figs. 3 to 7 in different stages of growth) and attain the adult state in the course of about two weeks when the wings are fully developed. Adults are known to live for two to four months and each female to lay about 200 to 300 eggs during her life.

As all adult and young bugs suck the grains serious damage may be caused. This insect ordinarily lives on wild grasses and migrates to paddy as noted above.

The only practicable remedy when the bug appears is to sweep up the bugs with hand nets (Text Fig. 22). The pest does not attack all varieties of paddy but some varieties of early autumn paddy are attractive. It has not been reported to cause damage for the last several years anywhere in the province. In case of attack resistant varieties of paddy have to be looked for. In the Philippines the bug is reported to be attracted by the odour of putrid meat which is saturated with a solution of 3 per cent sodium arsenate and hung in bags. The bugs are then either burnt with torches or caught in nets.

THE RICE GRAIN-NIBBLING CATERPILLAR.

(*Cirphis unipuncta* Haw. and *C. loreyi* Dup.)

VERNACULAR AND LOCAL NAMES.—*Garin* (Tenasserim—*Karen*); *Hnan-pyat-fo*, i.e., ear cutting pest (Moulmein); *Kama-Nook* (Tenasserim—*Talaing*); *Ngha-myaung-daung*; *Saba-hnan-fo*, i.e., paddy ear pest (Akyab); *Pra* (Leiktho-Gebba-Karen).

Plate 24.

Rice with ripening ears, is frequently attacked by this caterpillar which has the peculiar habit of climbing plants at night and nibbling off the stalks of the grains in the ear (Fig. 1). The grains fall on the ground and are lost. Whole stretches of ripening rice are not attacked but a field here and a field there in the midst of wide areas. The damage may thus be great. During the day time the caterpillar hides at the bases of clumps or in cracks in the soil. It feeds in this manner for only a few days, five or six days at the most, and then goes into the earth and turns into a pupa (Fig. 6) whence it emerges as a moth (Fig. 7). The moth lays eggs in hidden situations inside rolls of leaves or under leaf bases (Fig. 1). Young caterpillars hatching out of the eggs at first nibble tissues (Fig. 3) and later eat leaves of rice or grasses and it is only in the last few days of their life that they develop the grain-nibbling habit.

This pest occurs in three roles. (1) Ordinarily it feeds on grass, sorghum, maize or rice leaves, occurring in small numbers almost everywhere and practically throughout the year. (2) Grown up caterpillars nibble grains on rice ears if they happen to be present when ears ripen. (3) In its third role it occasionally occurs as an Army Worm after intervals of years and generally in years characterized by drought followed by late rains about October. In Burma the Army Worm generally occurs on sorghum and rarely on sugarcane and very rarely rice. The Army Worm is more fully described under sorghum at page 70.

When ears are observed to be nibbled it is advisable to harvest the crop quickly if fit for harvest. Nibbling can be prevented if the cultivator can undertake the trouble of shaking the plants in infested fields several times after sun down and also before dawn by pulling a rope across the infested field. Small heaps of straw or grass placed here and there in the infested field attract the caterpillars which hide under them and should be destroyed in the morning.

PESTS ON SORGHUM.**Cockchafer or white grubs.****(*Lachnosterna* sp.)****Text Fig. 86. (See Plate 7.)**

A cockchafer grub occurs regularly among sorghum roots especially in early rains in some parts of the province. The grubs eat the roots and kill off the young plants. As however, the crop is sown very thick, although thin and bare patches may appear, the loss is hardly felt. In some cases however the damage may be severe.

This chafer grub has practically the same life history as illustrated in Plate 7 and described on pages 20—21 but is really a different insect. The beetles find early sorghum fields a suitable place for oviposition with consequent loss. The beetles damage mulberry leaves at Mandalay.

PLATE 24

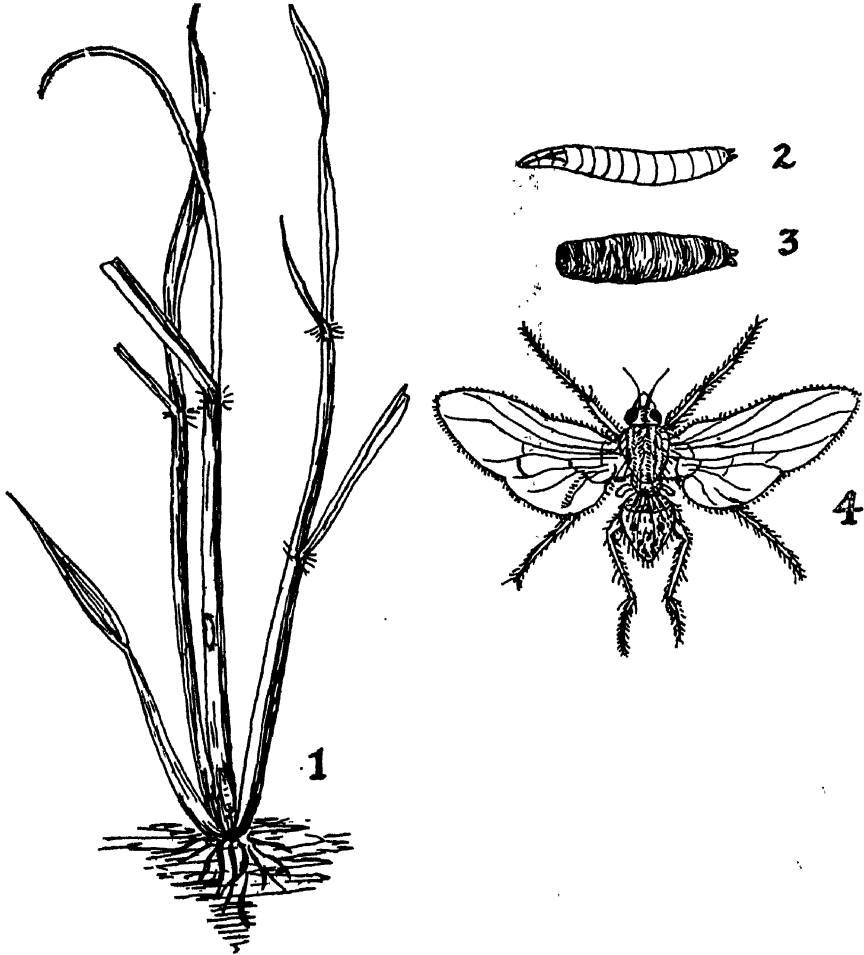


CIRPHIS UNIPUNCTA.
Rice Grain-nibbling Caterpillar.

Hardly anything can be done. The grubs develop rapidly and go down to rest and a late sown crop hardly suffers.

THE SORGHUM STEM BORER FLY.

(*Atherigona* sp.)



Text Fig. 34.

SORGHUM STEM BORER FLY. (*Atherigona* Sp.)

1. SORGHUM SEEDLING BORED.

2. MAGGOT, 3. PUPA, 4. FLY-(AFTER BALLARD AND RAO). (MUCH ENLARGED.)

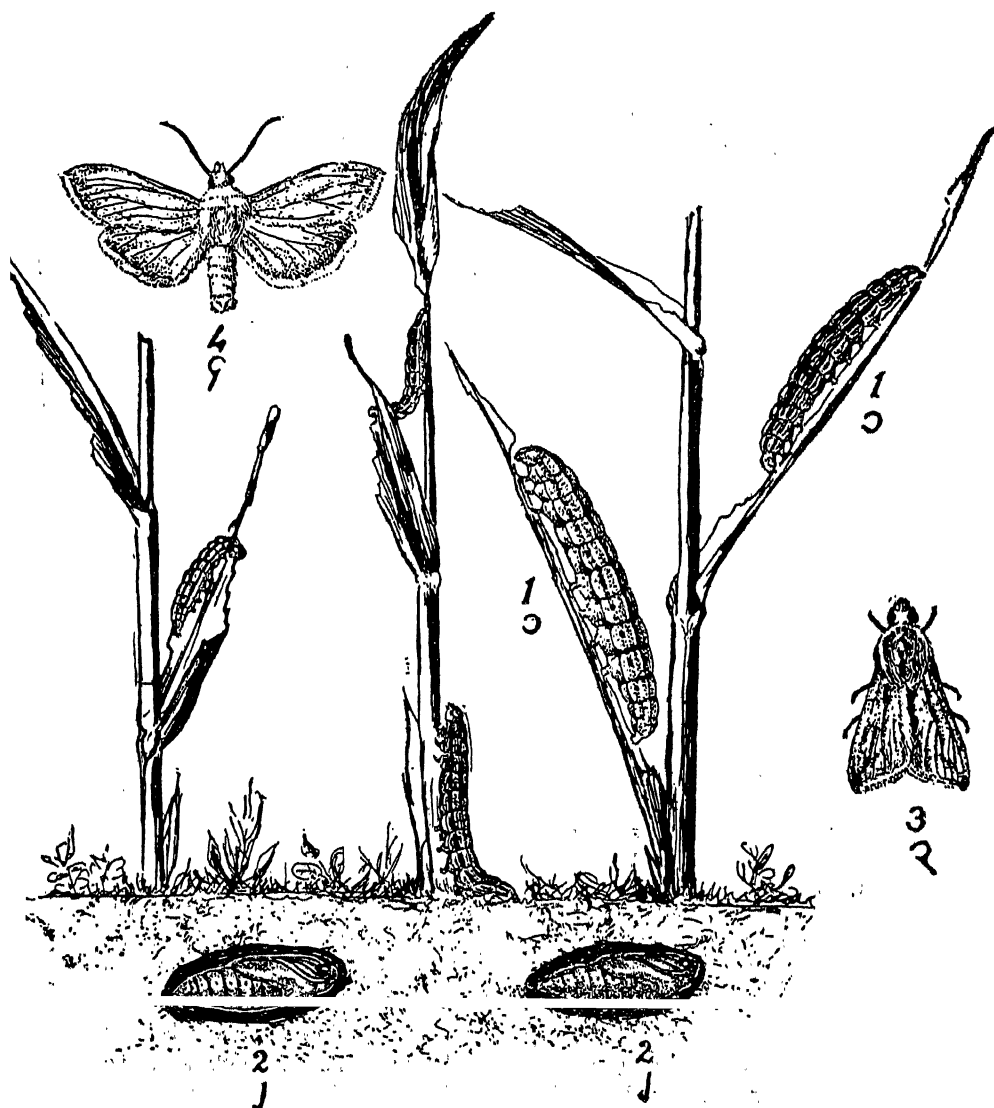
Young *pyaung* plants are attacked by fly maggots which bore the centre of the stem causing the heart leaf to dry. The maggots pupate inside the bored stem and ultimately emerge as small flies. The damage done does not amount to serious proportions as a rule and hardly anything can be done. Usually the crop is sown thick and the damage is hardly noticed.

THE ARMY WORM.

(*Cirphis unipuncta* Haw and *C. loreyi* Dup. and also *Borolia venalba* Mo. to a small extent.)

See Rice Grain Nibbling Caterpillar and Plate 24.

The most serious pest on sorghum is the Army Worm which however does not occur every year and may appear once in about ten years and in years of drought followed by late heavy rains. Where it occurs the crop may be devoured almost wholly (Text Fig. 35).



Text Fig. 35.

DAMAGE BY THE ARMY WORM.

These caterpillars (Figs. 3—5) appear in very large numbers all of a sudden, devour the leaves in a field and then move to other fields in large hordes. Hence the popular name "Army Worm," is given to them. It cannot be predicted when and where they will appear. The crop on which they usually occur in Burma is *Pyaung* (*Andropogon*). They occasionally occur on some introduced varieties of sugarcane and may also occur on rice.

After feeding for some days, when the caterpillars become full grown, they enter the earth and transform into pupae (Fig. 6). In the course of about a week and a half more they issue out of the pupae as moths (Fig. 7). It is from the eggs laid by such moths that the caterpillars hatch. Each female moth lays about 500 to 600 eggs in hidden situations, usually inside rolled leaves or under the leaf-bases encircling the stem (Fig. 1). Therefore the eggs are not visible. A large number of eggs, up to about 200, may be thrust at one place. The eggs hatch in about four days and the tiny young caterpillars live hiding usually inside rolled leaves and feed at night. They feed and grow for about 15 to 20 days before going into the ground to pupate. In the earlier part of their life they cannot eat much and are not noticed. When they grow they eat voraciously and devour entire fields in a few days. It is usually at this time the cultivator's attention is attracted to them.

The caterpillars may occur in such numbers that they literally cover the ground when moving to other fields. A large number of moths lay eggs at one place in order to be able to give birth to so many caterpillars. It cannot be ascertained from where so many moth appear all of a sudden. The caterpillars usually feed on all sorts of grasses. Under favourable conditions their number increases at some place. The resultant moths fly in swarms and settle in batches here and there and deposit eggs. Therefore batches or battalions of the "Army Worm" may occur simultaneously at several places which may be long distances apart.

As it cannot be predicted when and where the caterpillars will appear and as they are not noticed before they grow to the voracious and destructive stage, the only thing which is expected to give any result is to take immediate and vigorous action (1) to prevent them from moving to other fields and (2) to destroy them in all possible ways.

The caterpillars live and feed within a small area at first. In order to prevent them from being able to move to other fields a trench dug round the infested area is very helpful. The trench may be about eight inches to a foot or so deep and as wide as the width of a spade. The trench can be filled with water if available. If no water is available it is advisable to cover the caterpillars with a little earth as they fall into it and a man walking in the trench on this earth will be able to dispose of them successfully. Many caterpillars can be driven into the trench by shaking the plants with a rope.

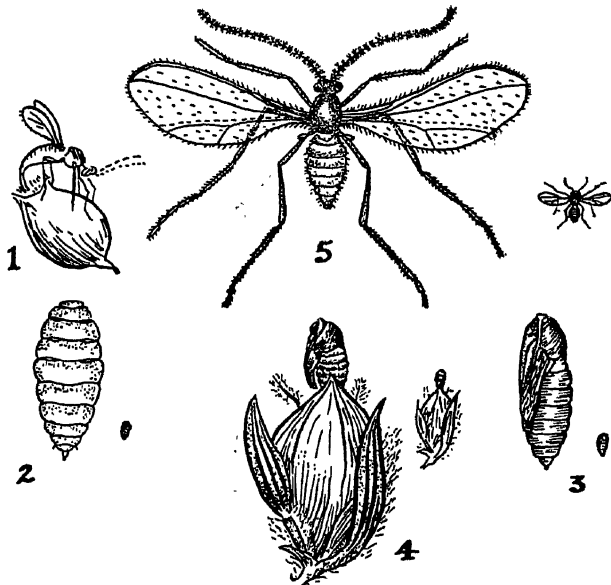
While many will be destroyed in the trench it is advisable to pick off by hand as many as possible and put them in vessels containing water and kerosene oil. Many live inside rolls of the top leaves or inside leaf-bases. They can be squeezed with the hand in such situations. Those falling and walking on the ground are better trampled or beaten with a stick.

Birds, especially mynahs (*za-yet*) devour many. In order to attract them some cooked rice may be spread near the field and branches of trees planted here and there to afford them a resting place.

When the caterpillars are successfully isolated in a small area by means of a trench it becomes easy to destroy them when they pupate under the surface of the soil. Usually the pest disappears after the first attack and a second attack seldom occurs. But in order to be on the safe side it is better to plough up the soil and roll it. Many pupae will be crushed, the exposed ones will be picked up by birds and many will be so buried that moths from them will not be able to emerge. Unless this measure is adopted and if the numerous moths which emerge lay eggs again there may be further severe damage.

Under the circumstances detailed above prompt action by the cultivators themselves is what is necessary. The delay of a few days will enable the caterpillars to do immense damage. Application of a poison on the plants which may kill the caterpillars when they eat the poison with the leaves requires expense, time and machinery to spread the poison, men to do the work and favourable climatic conditions, as the poison may be washed away by rain. The damage may be done before all this can be arranged. Prompt and vigorous action on the part of the cultivators with all the members of their families is the only remedy.

THE SORGHUM GRAIN MIDGE.
(*Cantarinia andropoginis* Felt.)



Text Fig. 36.

SORGHUM GRAIN MIDGE (*Cantarinia andropoginis*).

1. MIDGE DEPOSITING EGG, 2. MAGGOT, 3. PUPA, 4. PUPA WRIGGLING OUT OF A GRAIN BEFORE EMERGENCE, 5. MALE MIDGE; THE FEMALE HAS A LONG OVIPOSITOR (AFTER BALLARD).

The newly forming grains on sorghum heads are sometimes attacked by a small maggot which feeds inside and prevents the grain from forming, so that no seed is obtained. In bad cases of attack as much as about 50 to 60 per cent of the grains may be lost.

A minute gnat or fly deposits eggs in the newly forming grains and the maggots which hatch from these eggs cause the damage. When fullgrown the maggots pupate inside the empty grain and ultimately issue as the gnat or fly.

Hardly anything can be done to stop this damage. All varieties of sorghum do not suffer to the same extent. Resistant varieties should be grown.

SORGHUM HEAD WEBBING CATERPILLAR.

(*Stenachroia elongella* Hmps. n.)

This caterpillar occasionally occurs on sorghum heads webbing up the grains and eating them. It is however of rare occurrence. Individual heads usually suffer but whole fields are rarely affected.

Caterpillars which web the heads hatch from eggs laid by the moth and when full grown transform into pupae in the affected heads and ultimately issue as moths.

In order not to let the pest have a chance to increase to injurious numbers it is advisable to cut off the first affected heads and destroy the caterpillars in them. Affected heads are easily distinguished.

SORGHUM LEAF ROLLING CATERPILLAR.

(*Marasmia trapezalis* Gn.)

Plate 25.

A brownish-yellow somewhat transparent-bodied and spotted caterpillar (Figs. 1 and 2) occurs on sorghum leaves rolling them to a certain extent and eating them from inside the roll. When fullgrown the caterpillar pupates on the leaf (Fig. 3). The moths (Figs. 4 and 5) are observed flying in sorghum fields and depositing eggs on the leaves. The life-cycle takes about three weeks. The damage is rarely severe and the pest is of minor importance.

The rice leaf butterfly, the rice hairy caterpillar and the rice leaf-binding caterpillar also occur on sorghum and are of minor importance as on paddy.

PESTS ON MAIZE.

The leaf eating insects found on rice and sorghum may occur on the leaves.

The young cob may be occasionally attacked by the Tobacco Caterpillar (Text Fig. 59) and Linseed Caterpillar (Plate 58).

Aphids appear on the leaves.

The stem is occasionally bored by the Pink Shoot Borer of sugarcane (Plate 28).

Generally however this crop does not suffer appreciably from insect pests.

PESTS ON WHEAT AND BARLEY.

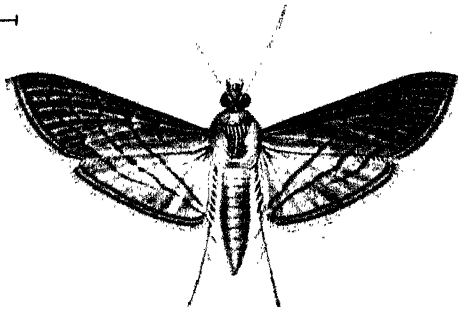
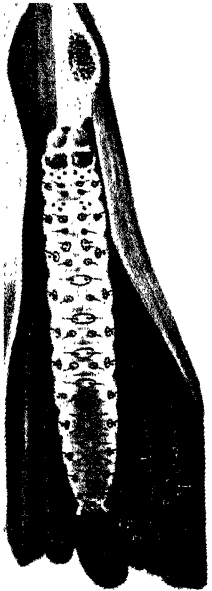
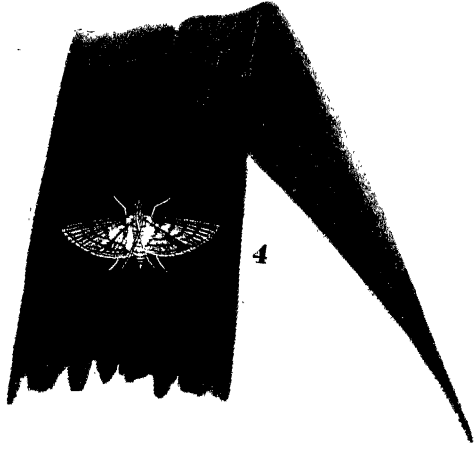
Wheat suffers occasionally from the attack of termites (Plate 5). This however seems to be connected with soil and climate and the attack is only in patches here and there. Hardly any control measures are practicable, beyond avoiding soils liable to attack.

Leaf eating caterpillars may occur but are rarely bad.

The Pink Shoot Borer of sugarcane (Plate 28) occasionally bores the stem but is seldom serious.

The really bad pest on this crop is aphid. Hardly any control measures can be practicable on a field scale. Lady-bird beetles and other beneficial insects which prey upon aphid should be encouraged and if not present in a field should be introduced from other fields.

Barley hardly suffers from any pest.



Sorghum Leaf-roller
(*Marasmia trapezalis*)

PESTS ON SUGARCANE.

Different pests attack sugarcane in different stages of growth. Also different pests are observed to be prevalent in different sugarcane areas in the province. Generally speaking this crop in middle (Kyaukse) and Lower Burma (Toungoo and Thatôn Districts) hardly suffers from any serious pest.

In Myitkyina District in Northern Burma however where its cultivation has expanded recently and where continuous ratooning is practised, Black Beetles and their grubs (chafer grubs) on roots and Woolly Aphis on leaves are serious pests and the Pink Shoot Borer is destructive to new shoots.

The following insects occur on different parts and at different stages of the crop. Their importance as regards injuriousness is indicated as minor or major :—

On sets	...	Termites (white ants)—Major in sandy soil. Mole crickets (<i>Gryllotalpa africana</i>)—Minor. Black beetles (<i>Alissonotum impressicolle</i> and others)—Minor. Termites, corroding base—Major in sandy soil. Mole crickets gnawing into base—Minor. Wire worms (<i>Heteroderes lenis</i>) boring from base—Minor. Black beetles (<i>Alissonotum impressicolle</i>) gnawing into base—Major.
On young shoots...	†	White grubs (<i>Alissonotum</i> spp. and <i>Lachnosterna</i> sp.) gnawing into base. <i>Alissonotum</i> is very serious. Yellow Shoot Borer (<i>Scirpophaga nivella</i>) boring from top—Minor. Pink Shoot Borer (<i>Sesamia inferens</i>) boring from top—Major. Striped Shoot Borer (<i>Argyria sticticrasis</i>) boring from top—Major. Shoot borer weevil (<i>Hypomeces squamosus</i>) grubs boring from side—Minor.

- Woolly aphis (*Oregma lanigera*) sucking leaves—Major.
- Aleurodids (*Aleurolobus barodensis*) sucking leaves—Minor, occasionally Major.
- Pink mealy bugs (*Ripersia sacchari*) sucking stem—Minor.
- On grown plants ... { Yellow Top Borer (*Scirpophaga nivella*)—Minor.
- Spotted Stem Borer (*Argyria tumidicostalis*)—Minor.
- Brown Weevil Borer (*Trochorrhopalus sacchari*) grubs boring stem—Minor but major in ratoons.
- White grubs eating roots (*Lachnosterna* sp. and *Alissonotum* spp.). *Alissonotum* is very serious.
- Caterpillars eating leaves; those found on rice and sorghum occur on it sporadically, the Army Worm (*Cirphis unipuncta*) however proving bad occasionally, specially on broad leaved introduced varieties.
- In all stages of growth. {
- Thrips—only on young leaves—Minor.
- Leaf hopper bugs (*Pyrilla aberrans*) sucking leaves—Minor.

Some of the borer pests present in India have not been observed to occur in Burma especially *Chilo simplex* and *Emmalocera depressella*. Their entry should be guarded against. No cane, sorghum, maize or thick grass stems should be imported without a certificate from an entomologist.

TERMITES.

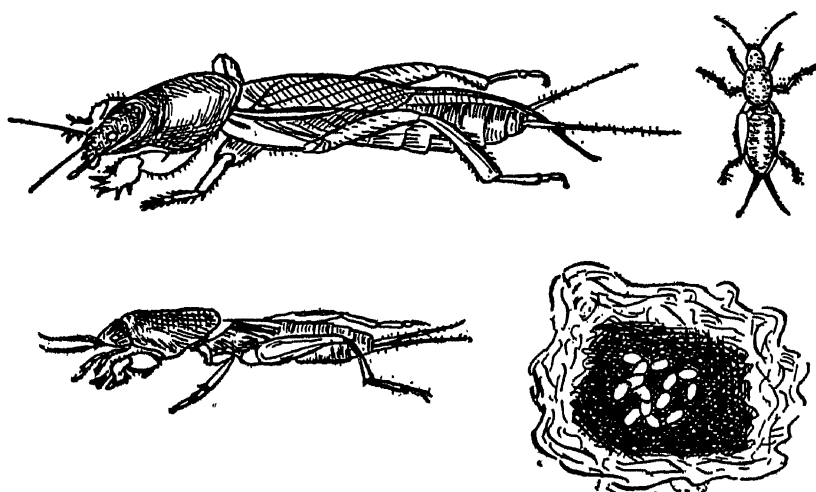
Plate 5.

Termites prove bad on this crop in light sandy soils. It is better not to attempt growing sugarcane in such soils. The termites eat the sets planted and also corrode the bases of new shoots which die as a consequence. Grown plants may also be attacked.

Sets dipped in lead arsenate solution are avoided to a great extent. Where irrigation can be practised crude oil emulsion mixed in the water keeps off the termites but only for about one to two weeks. The smell of coaltar imparted to the soil by springling of coaltar in water has also the same effect.

MOLE CRICKET.

(*Gryllotalpa africana* Pal.)



Text Fig. 37.

THE MOLE CRICKET (*Gryllotalpa africana*).

EGGS, NYMPHS AND ADULT CRICKET. X2.

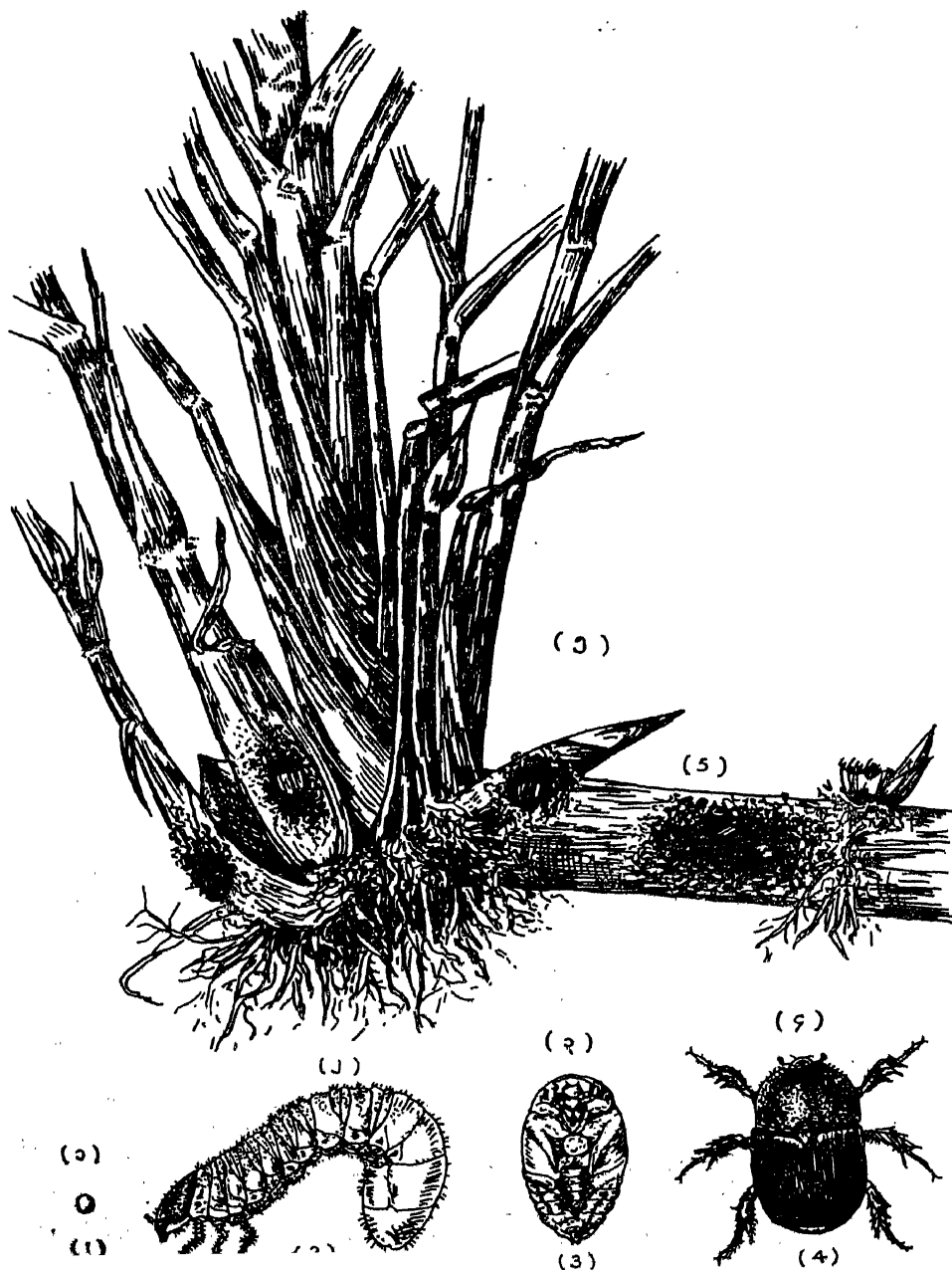
The mole cricket sometimes nibbles the buds of sets planted in the soil, eats away the root rings at nodes and may gnaw a hole in the set and also at the bases of new shoots causing dead heart, but it seldom occurs in injurious numbers and seems to prefer somewhat waterlogged places. It has been observed only at Salmaw in Myitkyina District.

The cricket lives and breeds underground and has the habit of working its passage under the surface of damp soils. Normally it seems to be predaceous. Eggs are laid in the burrow and the young crickets take several months to grow and attain the adult state.

BLACK BEETLES.

(Alissonotum impressicollis Arr.)VERNACULAR AND LOCAL NAME.—*Kyan-po* or *kyan-bo* (Myitkyina).

Plate 26.



THE BLACK BEETLE PEST OF SUGARCANE

This is the most serious and along with it the following also occur but not in injurious numbers, viz., *Alissonotum crassum*, *Heteronychus lioderes* and *H. sublaevis*.

In areas in Myitkyina District where growing of sugarcane is undertaken in clearings among *kaing* grass this black beetle appears in large numbers about the month of April and damages sugarcane in the manner shown in the illustration. In the absence of growing shoots it gnaws into the sets used in planting. Shoots are gnawed under ground and their heart leaf wilts immediately and then dries (Fig. 5). If gnawed sufficiently the shoots dry wholly. The attack to the shoots happens to be at such a place at the base that no fresh tillers grow. As the beetles appear in large numbers, congregate in some places and feed actively, very severe damage is done to whole fields and in a very short time. Similar damage by the same beetle occurs to cane grown under similar conditions in Assam.

Life-history of the Beetle.—The beetles appear in April and feed till about the early part of June causing damage as described above. Then they go further down into the earth and rest till about September to October when they stir out for laying eggs and again feed and cause damage. Small white eggs (Fig. 1) are deposited loosely here and there in the soil at the rate of about a hundred by each female beetle. The beetles die about December. In the meantime grubs or *po-di-gaung* hatch from the eggs and feed on sugarcane roots. Canes, especially ratoon canes suffer from damage to their roots by the grubs which grow and become fullgrown (Fig. 2) by about February-March. They then turn into pupae (Fig. 3). From the pupa the beetle (Fig. 4) issues in April and the same life-history is repeated.

The beetle normally breeds and feeds on *kaing* grass in the same manner as they do on sugarcane. Sugarcane is however a more attractive food and when grown among this grass the beetles turn their attention to it. Also well ploughed sugarcane fields, and especially old ratoon roots, afford better facilities for the grubs to develop and thus help the pest to increase in number.

Control measures.—(1) It is necessary to cultivate the soil well in the sugarcane fields in December, January, February and March and either pick off or crush the *po-di-gaung* present. Many of the grubs exposed by the plough are picked up by crows and other birds. The more thoroughly this is done the less will be the number of beetles which issue in April. It is not advisable to let sugarcane grow and remain in the field continuously beyond the first ratoon. After harvesting the crop the field should be ploughed up and the roots burnt. No sugarcane should be planted in the same field at least for a year.

(2) When the beetles appear as will be easily evident from the wilting and drying of the heart-leaves of shoots, they should be promptly collected from the earth round the bases of the clumps. If

this is carried out carefully there will be less *po-di-gaung* and less beetles next season.

The grubs can simply be crushed and need not be collected. When collected they can be thrown into deep water or fed to crows and fowls or buried in a deep pit in hard soil and rammed down. The beetles can be similarly crushed or collected and killed by being placed in boiling water.

SHOOT BORERS OF SUGARCANE.

VERNACULAR AND LOCAL NAME.—*Oo-shauk-po*, i.e., going through heart (Allanmyo).

THE YELLOW SHOOT BORER.

(*Scirpophaga nivella* Fab.)

Plate 27.

This caterpillar is a typical shoot borer both in young and grown cane. Fig. 2 shows an affected grown cane with dead heart and as a consequence branches growing from near the top. Affected new shoots also cease to grow and throw up tillers from the base. When the caterpillar is fullfed and fullgrown (Fig. 5 shows it enlarged) it bores an outlet as shown in Fig. 6 for the future moth and protects the mouth of the opening with a few papery partitions and then transforms into a pupa (Fig. 7 shows a female pupa and Fig. 8 a male one). The moths are white and the female has a reddish or yellow tuft of hairs at the hind end. Eggs are laid on leaves and covered with these hairs (Figs. 4 and 3). Egg masses on the leaves are therefore easily visible. On hatching from the eggs the young caterpillars are scattered by wind to different shoots into which they bore. When once inside a shoot this borer remains and feeds there and is incapable of moving to a new shoot. Its body is yellow and soft and it cannot be confused with the other borers. The life-cycle ordinarily occupies about six weeks. Most of the caterpillars hibernate in winter.

THE PINK SHOOT BORER.

(*Sesamia inferens* Wlk.)

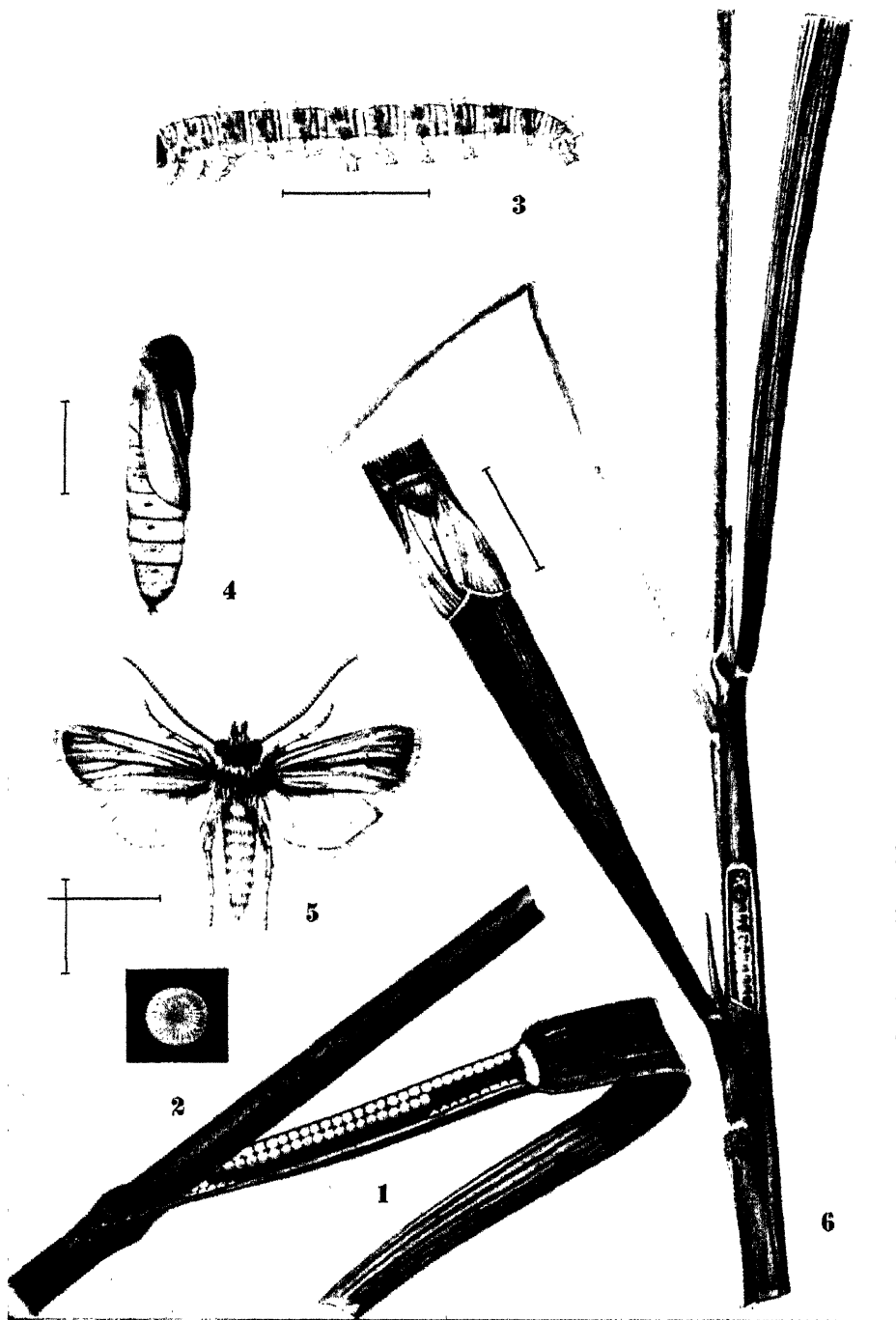
Plate 28.

This shoot borer occurs also on wheat, barley, oats, millets, sorghum, maize and several grasses. The plate illustrates the life-history on wheat. Eggs are deposited in hidden situations under the leaf sheaths (Fig. 1 and Fig. 2 shows one egg enlarged). The caterpillars bore inside the shoot and move from shoot to shoot or plant to plant. They have a pink flesh-coloured body without any marking. When fullgrown they pupate in the tunnels they bore. Fig. 4 shows a pupa and Figs. 5 and 6 moths in flying and sitting postures. The moths are straw coloured.

The life-cycle ordinarily occupies about seven weeks, viz., egg 2 days, larva 30 days and pupa 12 days. Each female moth lays about 400 to 500 eggs and up to about 200 eggs may be laid on a single plant. The young caterpillars disperse after hatching.

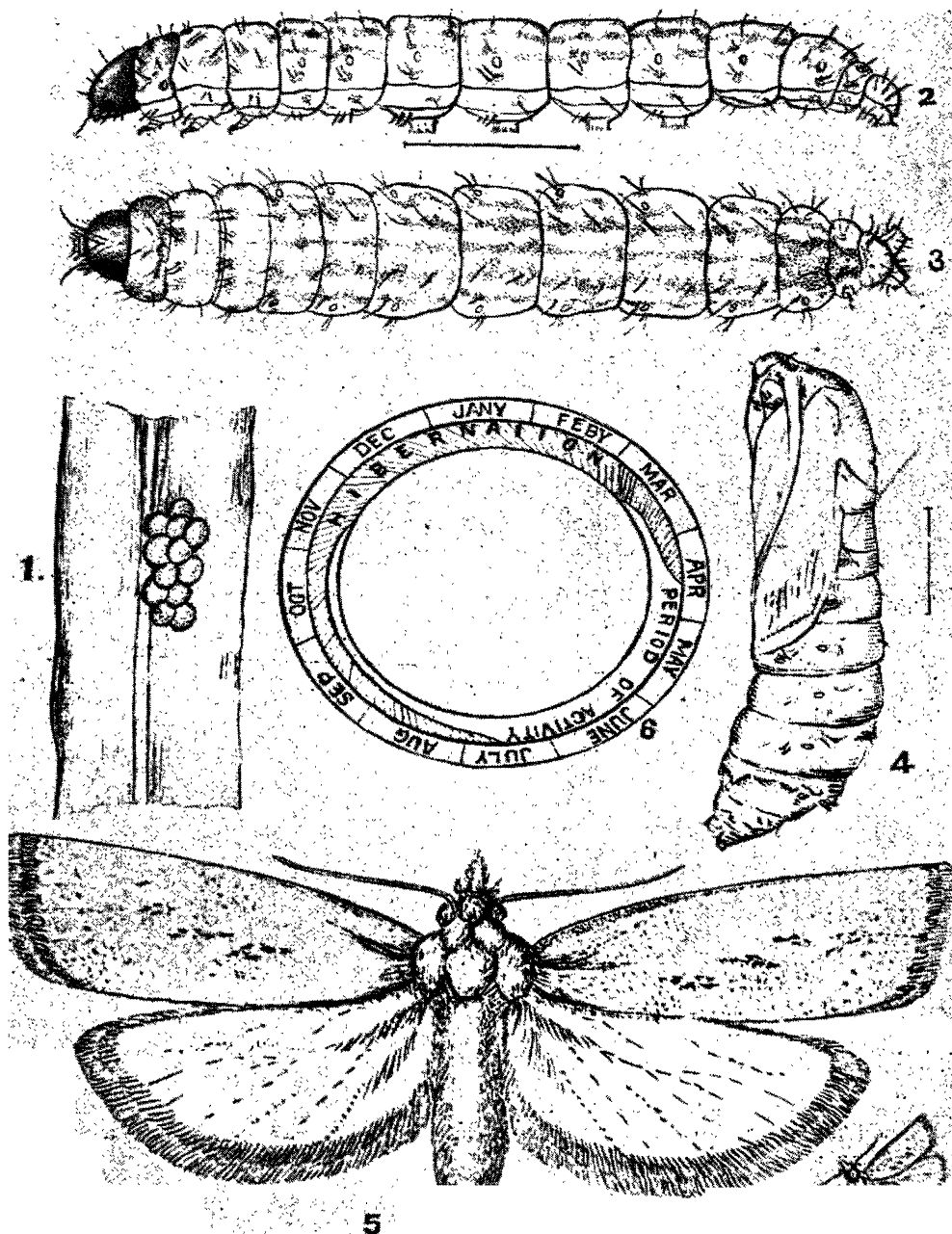


Yellow Shoot Borer of cane
(*Scirpophaga nivella*)



Pink Shoot Borer of cane
(*Sesamia inferens*)

STRIPED SHOOT BORER.
(Argyria sticticraspis Hmps.)
 Plate 29.

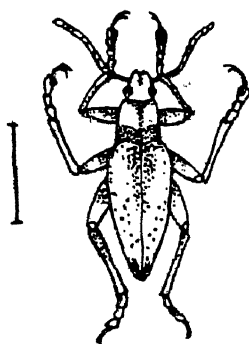


This borer (Fig. 2 from side, 3 from back) has stripes on its back. Eggs (Fig. 1) are laid on leaves or stems in a cluster and arranged like the tiles on a roof and are not covered with hairs. The egg cluster looks like a scale. The caterpillars bore shoots causing dead hearts and pupate (Fig. 4) in the tunnel in the shoot. Moths (Fig. 5) are straw coloured. The life-cycle ordinarily occupies about five to six weeks, *viz.*, egg about 3 days, larva about 30 days and pupa about 7 days. Most caterpillars hibernate in winter.

This insect occurs also in sorghum and other plants.

SHOOT BORER WEEVIL.

(*Hypomeces squamosus* F.)

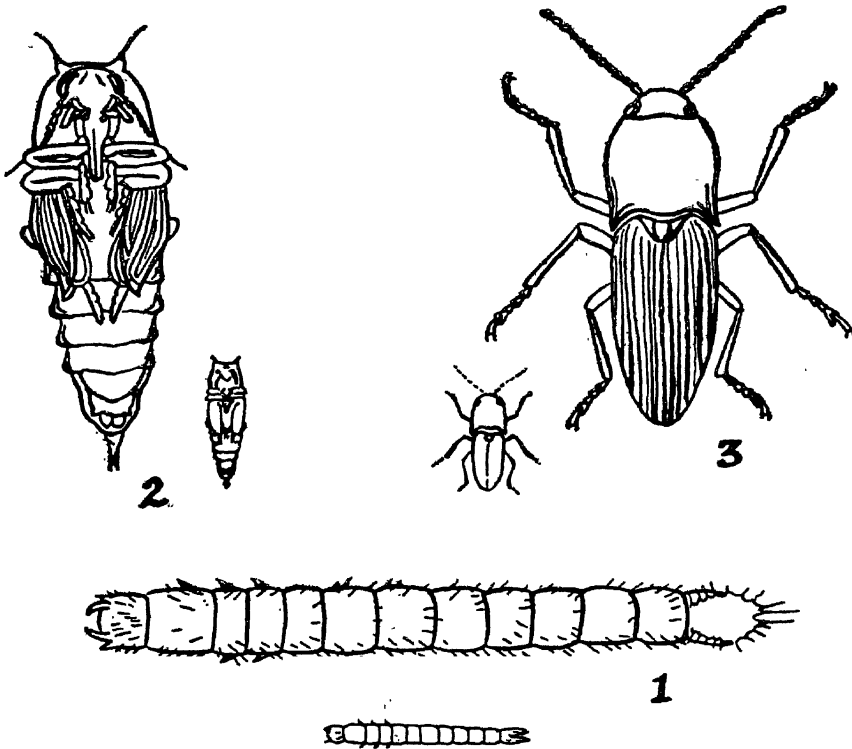


Text Fig. 38.

SHOOT BORER WEEVIL OF CANE (*Hypomeces squamosus*).

Grubs of this grey weevil have been observed to live freely in the soil and bore shoots from a side causing dead heart in Myitkyina District but not in injurious numbers.

WIRE-WORM BORER.

(Heteroderes lenis Cand.)

Text Fig. 39.

WIRE-WORM (*Heteroderes lenis*).

1. GRUB, 2 PUPA, 3. CLICK BEETLE.

(AFTER PUSA BULL 89.)

Wire-worms or grubs of click beetles (*Heteroderes lenis* and probably others) bore sugarcane shoots from the base through a hole which extends up to the growing point which is destroyed producing dead heart. The grub bores the centre of the shoot for some time and then leaves it and attacks a new shoot. A single grub is thus responsible for the destruction of several shoots in its larval life which extends over several months. The beetle seems to complete only one life-cycle during the year.

Control.—Of the three shoot borer caterpillars the pink one (*Sesamia*) has been observed to occur in large numbers in Myitkyina District. In the case of all of them the shoots with dead hearts should be cut out near the base and burnt thus destroying the borers and preventing them from developing and increasing in number. New tillers appear from the base of the shoots. Even if the affected shoot is left uncut it does not grow and throws up tillers from the base. If the yellow one (*Scirpophaga*) appears in any number its egg clusters should be looked for and destroyed. Egg clusters are easily visible to one walking between cane rows.

STEM BORERS OF SUGARCANE.

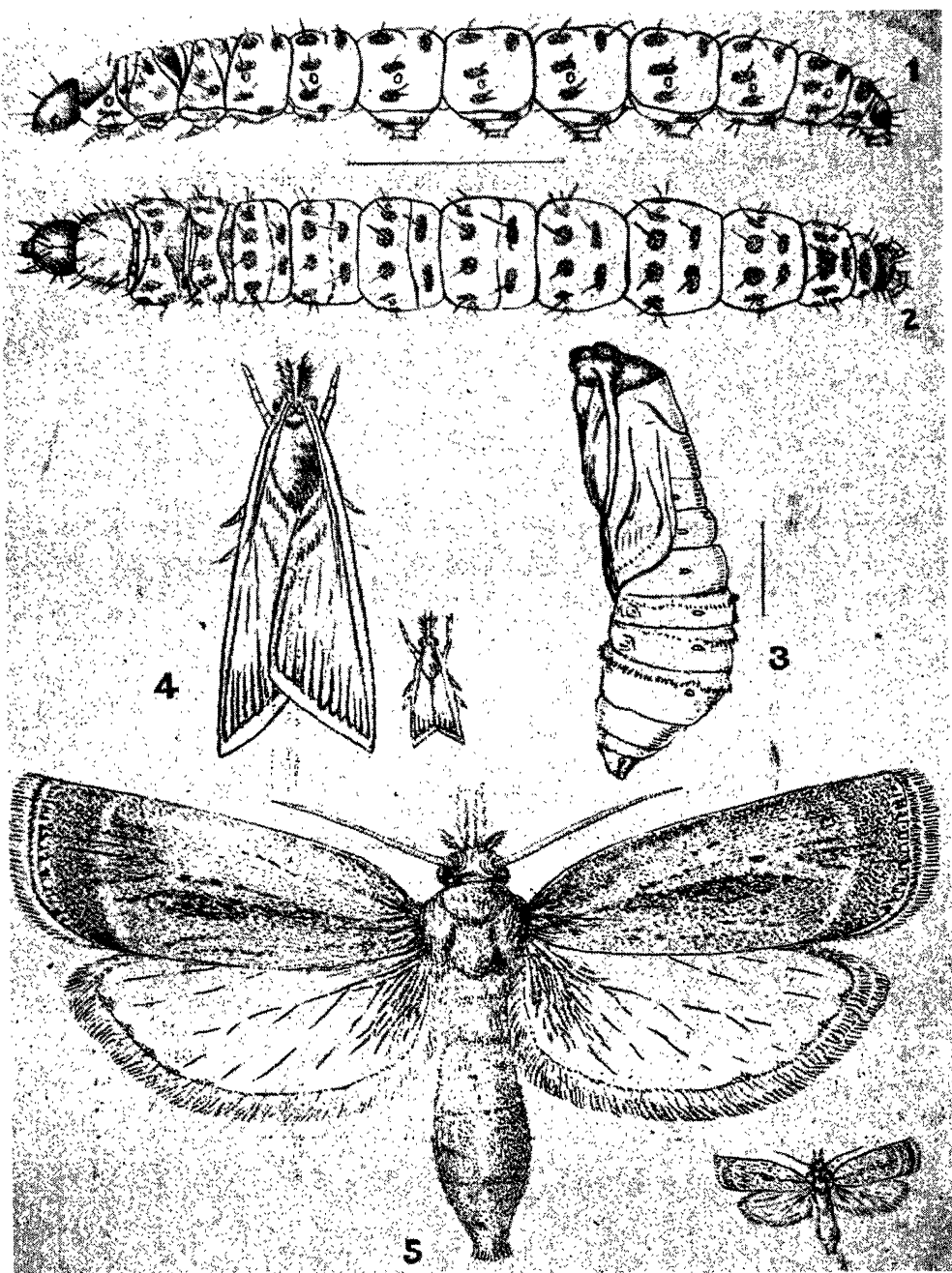
The Pink and Striped Shoot Borers occasionally bore stems of cane, but seldom in any number. *Diatroea venosata* Wlk. with caterpillars having large spots on the body and *D. auricilia* Dgn. with striped caterpillars occasionally occur as stem borers but never in injurious numbers.

The real stem borers are described below.

THE SPOTTED STEM BORER.

(Argyria tumidicostalis Hmps.)

Plate 30.



SPOTTED STEM BORER OF CANE.

This borer has a peculiar habit of remaining confined to individual clumps of grown canes and all the canes in the clump may be affected. Usually there are several caterpillars boring a cane which is therefore severely damaged. Fortunately the pest is never widely spread, only clumps here and there suffering.

Eggs are laid on the leaf or stem in a cluster arranged like the tiles on a roof. The caterpillars (Fig. 1 from side, 2 from back) bore and pupate inside the stem. The detailed life-history and seasonal behaviour of this insect are not known.

The damaged clumps, which can be recognized by the emission of dust from the stems, should be cut out and burnt in order to prevent increase.

THE BROWN WEEVIL BORER.

(*Trochorrhopalus sacchari* Mrshl.)



Text Fig. 40.

BROWN WEEVIL BORER OF SUGARCANE STEM.

(*Trochorrhopalus sacchari* MRSHL.)

This weevil borer of cane occurred in large numbers on ratoon canes in Sahmaw estate (Myitkyina District) causing the ratoons to fail.

Weevils are active about April when eggs are laid in the stems near the base. Grubs, usually several in one stem, feed by tunnelling in the stem. The tunnels however are not extensive. By about September the grubs are fullgrown and form pupal cells in the tunnels in which they pupate and attain the adult state in the course of about a week. The weevils however do not leave the pupal cells until about April next year.

The weevil is of no importance where no ratooning is practised. Where fields are ploughed up after the first ratoon and the roots burnt the weevils are automatically controlled.

PINK MEALY BUGS ON STEM.

(*Ripersia sacchari* Gr.)

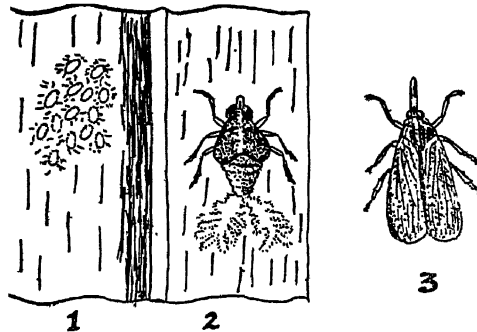
Plate 11, Fig. 1.

It is the same insect which occurs on paddy stems and has been described on page 66. Its presence can only be detected when the leaf sheaths are removed. If it occurs in large numbers the drain on the plant may be severe. The simplest thing would be to strip the plants of all side leaves. The insects soon drop off.

On leaves of sugarcane.

Caterpillars occurring on rice and sorghum leaves may be found on leaves of cane but are hardly of much importance except the Army Worm which, unless promptly checked, may strip the plants of all leaves (see Plate 24 and page 70.) The Army Worm has so far been observed to occur only on board leaved thick canes, such as Striped Mauritius, etc.

Thrips (see Text Fig. 3) occasionally occur on young plants in the same way as on young rice plants making the tips of leaves look sickly.



Text Fig. 41.

LEAF HOPPER BUG ON CANE (*Pyrrilla aberrans*).

1. EGGS ON LEAF, 2. NYMPH, 3. ADULT HOPPER.

(AFTER MISRA.)

Leaf hopper bugs (Text Fig. 41) when occurring in large numbers as they do in some places in India and other countries, may cause serious damage, but they have not been observed to appear in injurious numbers in Burma. The bugs lay eggs on leaves or stem. The young

nymphs have tufted white outgrowths at the hind end and hop from plant to plant. The winged adults also hop about. All suck the juice of the leaves. An allied leaf hopper on sugarcane in Hawaii has been controlled by the introduction of a bug which sucks the eggs of the leaf hoppers.

The two sucking insects on leaves which have been observed to be bad are the sugarcane Mealy Wings and the sugarcane Woolly Aphis.

THE SUGARCANE MEALY-WINGS.

(*Aleurolobus barodensis* Mask.)

Plate 31.

The insect appears as black oval spots on the leaves usually of fully grown canes. The spots are really the stationary nymphs of the Mealy Wings (Figs. 7 and 8) which lay eggs in masses (Fig. 2) on the leaves. Both adults and nymphs suck the juice of the leaves. As sometimes the entire leaves get covered with nymphs the drain on the plants is severe with consequent interference with growth and sugar content. The life-cycle takes only about three weeks. Therefore the insect increases and spreads fairly rapidly unless controlled.

For a cultivator who keeps watch on his field and notices the occurrence of the pest early the simplest plan is to cut off the affected leaves and burn them. This controls the pest effectively.

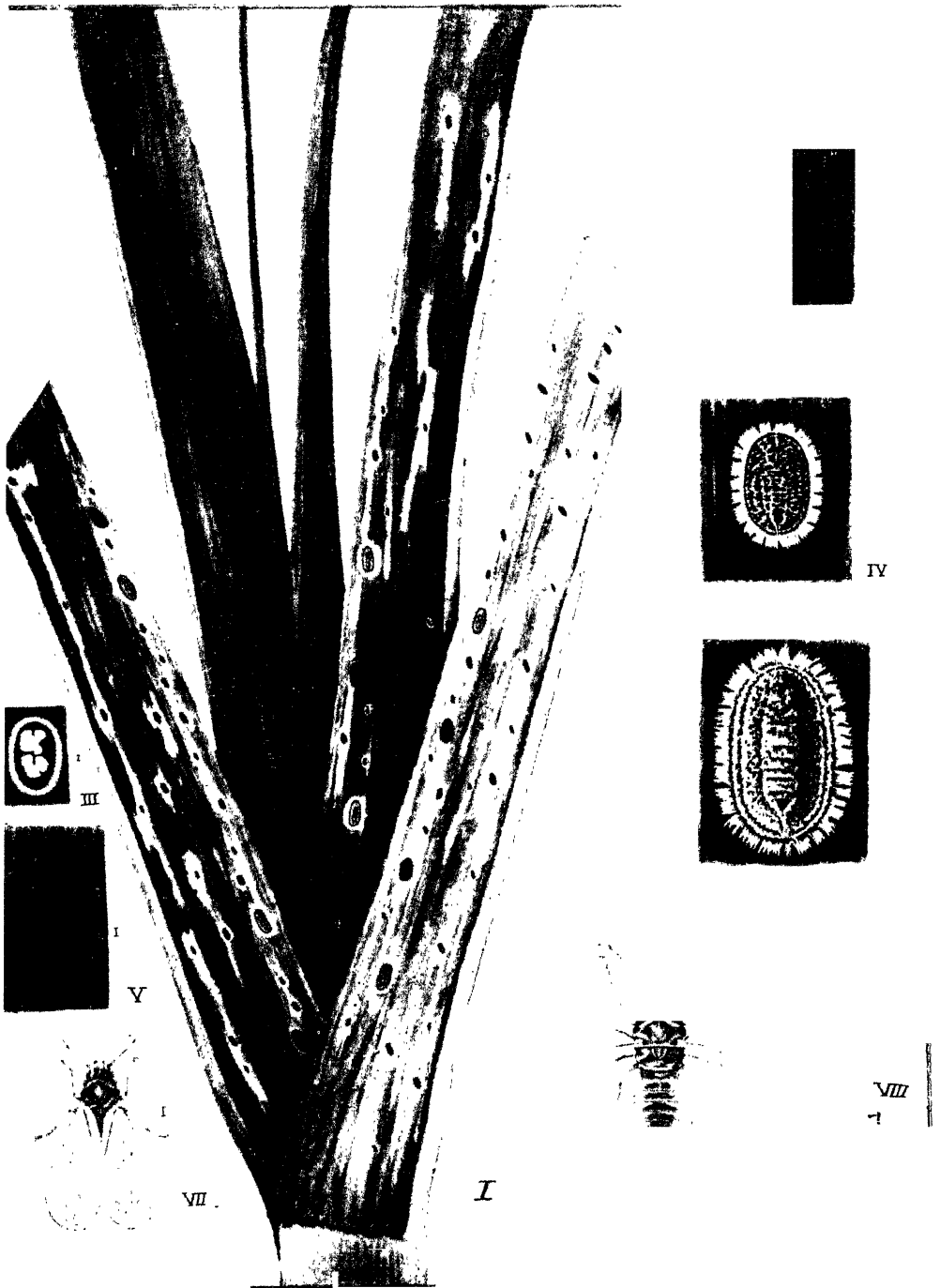
Spraying or washing the leaves if practicable with rosin compound solution is also effective as the insects are killed off.

THE WOOLLY APHIS.

(*Oregma lanigera* Zehnt.)

This insect occurs on the under surfaces of sugarcane leaves. Its life-history is similar to that of the plant louse described earlier and illustrated in Plate 1 with however this difference that it develops a filamentous woolly covering on its body. When young it is dirty greenish yellow in colour. As it grows a little a white powder appears and covers its body and with further growth this powdery substance develops into white filaments. As many sit together on the leaf the filaments on their body look like a white covering on the leaf. Whole fields and whole areas of cane soon become covered with aphids and look white.

As millions and millions go on sucking the juice of the canes day and night the plants can not stand such loss of juice, become stunted and may dry up. Even when they do not dry up they do not have much



Sugarcane Mealy-wing
(*Aleurolobus barodensi*)

juice and the juice they contain is of very poor quality. This insect is therefore a very serious pest and all cane cultivators should be on their guard against it. If they take the simple steps described below regularly and systematically the damage can be stopped entirely.

The owners of canes should go through their fields at least once every three or four days and any leaf affected by this insect should be cut off and placed in a cloth bag, or bucket or tightly woven basket so that the insects may not fall off from the leaf and crawl on to other plants. All affected leaves should be gathered in this manner and at once burnt with the insects. Whole fields are never infected at once. If the newly infected leaves are disposed of in this manner the insect does not get a chance of multiplying, increasing and spreading.

PESTS ON PEAS AND BEANS.

The peas and beans grown in Burma fall under the following groups and different groups have more or less different pests which are described below. Some groups are almost wholly resistant. Before describing the pests short notes on the liability of the different groups to attack or otherwise will be helpful.

On *Pegyi* or *lablab* group.

Pegyi (*Dolichos lablab*), the Indian bean, and its varieties, viz., *maung-ma-khaw-pe*, *pe-seikgyo*, *shwe-yinma*, *dunghaw*, etc., fall under this group.

The leaves of seedlings suffer from the striped flea beetle (Text Fig. 43) and those of grown plants from the common hairy caterpillar (Plate 32). The seeds in the pods are attacked by the *phaseoli* pulse beetle (Text Fig. 46). *Aphis* occurs on shoots and pods. A few other insects occur but are of minor importance.

On *Pegya* or *lunatus* group.

The types and varieties of *Phaseolus lunatus* fall under this group, viz., *pegya* or Rangoon red bean, *pebyugale* or small white Rangoon bean, *pegadiba*, another Rangoon red bean and the introduced butter beans commonly grouped as *htawbape*, or *moki-pe*.

The striped flea beetle causes holes in the leaves of seedlings, rarely causing serious damage. The beetle leaves the plants as they grow. Hardly any other pest of importance occurs on them. One year the introduced Madagascar bean seeds were bored when planted in the ground by a click beetle grub similar in life-history to that illustrated in Text Fig. 39. Such attack is rare in favourable seasons.

On Cow-peas (*Pelon*) or *vigna* group.

As many as about fifteen types and varieties of cow-peas are grown under various local names, such as *pelon*, *nadawpe*, *tazaungmon-pe*, *thon-la-pe*, *pedaukshe*, *yarpe*, *pegyaung*, *petaungtaing*, *yet-le-zai*, *shan-pegya*, etc.

The striped flea beetle attacks them persistently throughout the life of the plants, the leaves showing many holes. The stems of young plants are frequently attacked by the stem fly (Text Fig. 48). The leaves in any stage may be attacked by the *Epilachna* beetles and their spiny grubs (Plate 67, Figs. 10—12). Pods are bored by pod borer caterpillars and the seeds in the pods are attacked by the *analis* (Text Fig. 47) and *chinensis* (Plate 84, Figs. 1 and 2) pulse beetles. *Aphis* occurs on shoots and pods.

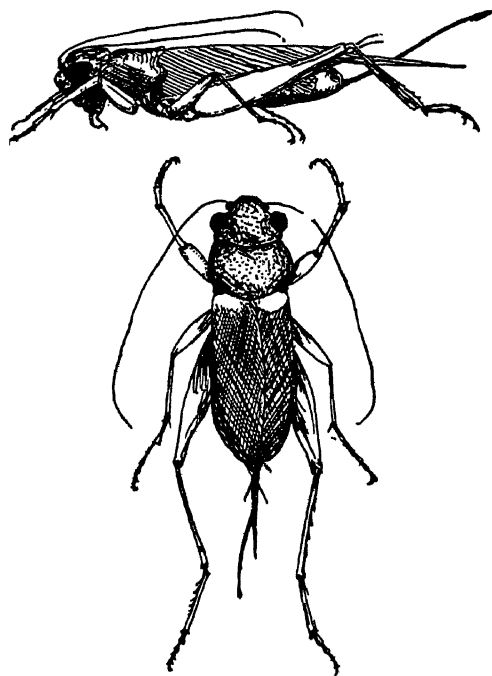
On *Matpe* or *mungo* group.

Matpe (*Phaseolus mungo*) and its varieties, *penauk*, etc., and *pedisein* (*Phaseolus aureus*) and its local varieties come under this group. Leaves of seedlings suffer from the striped flea beetle. The common hairy caterpillar (Plate 32) attacks leaves and may occur in any stage. Pods are bored by caterpillars and the seeds in the pods are attacked by the *analis* pulse beetle. Aphis occurs on pods and shoots. The Green Bug (Plate 40) occurs on pods and a smaller black bug (*Coptosoma*) with similar habits may also occur.

On Grams (*kalabe*).

Grams (*Cicer arietinum*) include the Burmese and the introduced Karachi ones. A whitish-yellow variety, locally known as *kabuli* is also grown on a small scale.

Gram sown in silted river beds (*Kyun*) and flooded lands are cut by Cutworms (Plate 33) and also the two-spotted field cricket (Text Fig. 42). Leaf eating caterpillars may cause a little damage. The pod boring caterpillar (Plate 35) when occurring in numbers causes some damage.



Text Fig. 42.

TWO SPOTTED CRICKET (*Liogryllus bimaculatus*).

On Pigeon Peas (*Pe-sinngon*).

Several types of pigeon peas are grown. Many insects occur on them, but the one to cause severe damage in some years is the spotted pod boring caterpillar (Plate 39) which develops the habit of webbing up the flower heads and eating the flowers. The gram pod borer caterpillar (Plate 35) occurs on it boring pods and eating seeds in the same way as gram. A hair-streak butterfly caterpillar (Plate 38) and two plume moth caterpillars (Plate 36) also bore pods to a certain extent. The seeds in the pods are attacked by the *chinensis* pulse beetle badly in some varieties (Plate 84, Figs. 1 and 2). A few other insects of minor importance also occur on this crop.

The insects cause a good deal of damage in the aggregate, but as the plants grow well and put forth a profusion of flowers and pods the damage is somewhat hidden.

On Peas (*Sadawpe*).

Peas are grown on a small scale.

When not grown in suitable conditions the stem fly (Text Fig. 48) kills many plants. Two leaf eating caterpillars (Plates 34 and 58), a pod borer caterpillar (Plate 37) and the *chinensis* pulse beetle occur to some extent.

On Soy Beans (*Pengapi*).

Soy beans are not grown on a large scale and comprise a few varieties.

A hare eats away young plants which require protection. Hardly any insect pest of importance occurs on this crop.

On Chickling Vetch (*Pe-chimboung*).

This is a crop of very small importance and comprises a single variety.

The only insect of importance is the snouted moth pod borer caterpillar (Plate 37).

On Lentil (*Peyaza*).

This crop is not of much importance and comprises a single type. Hardly any insect of importance occurs on it.

On Horse Gram (*Pebizat*).

This pulse is not of much importance and it hardly suffers from any insect of importance.

On Cluster Beans (*Pe-weeli*).

Cluster beans are grown for green pods used as vegetables and are not known to suffer from any pest of importance.

On Kidney Beans or *vulgaris* group.

These beans comprise several types grown only for green pods used as vegetables.

The plants suffer from the stem fly (Text Fig. 48) and also occasionally from the stem borer beetle (Text Fig. 49).

On *Pe-mylt* (*Psophocarpus tetragonolobus*).

This is grown extensively mainly for the roots which are largely eaten boiled. The four-winged pods in the green condition are also used as vegetable.

It is not known to suffer from any insect.

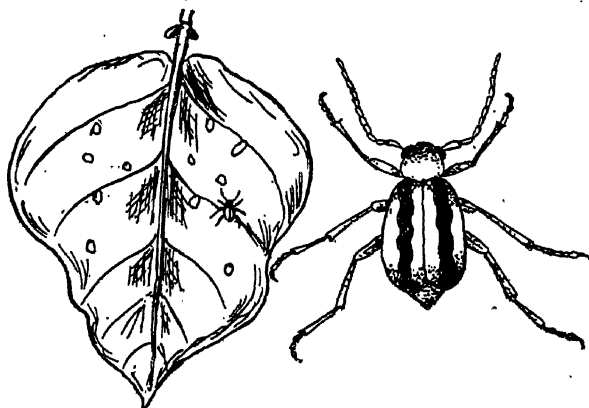
On Chinese Yam (*Pe-sein-sa*).

This crop is extensively grown for its sweetish roots which are eaten raw.

It suffers from no insect.

THE STRIPED FLEA BEETLE.

(*Luperodes suturalis* Mots.)



Text Fig. 43.

STRIPED FLEA BEETLE (*Luperodes suturalis*) (Natural size on leaf).

The small yellow-coloured beetle with black stripes on the back is a fairly bad pest on peas and beans. It bites holes in the leaves of seedlings of almost all kinds of peas and beans, the plants as they grow becoming immune except the cow-peas which may be attacked in all stages. The beetles also attack flower buds and pods like those of common beans (*Dolichos lablab*) to some extent.

The beetle is active mostly in early morning and late in the evening and at night. As the sun rises it goes into hiding and is hardly met with during the day time. Occasionally it may however be found on flower buds even of high plants like pigeon peas during the day, apparently on account of the shade provided by the thick foliage of the plants.

The attack certainly interferes with proper growth of the plants which however do not die.

A repellent such as kerosenised dust or ashes or Bordeaux Mixture may be used in the garden. Hardly anything is practicable on a field scale.

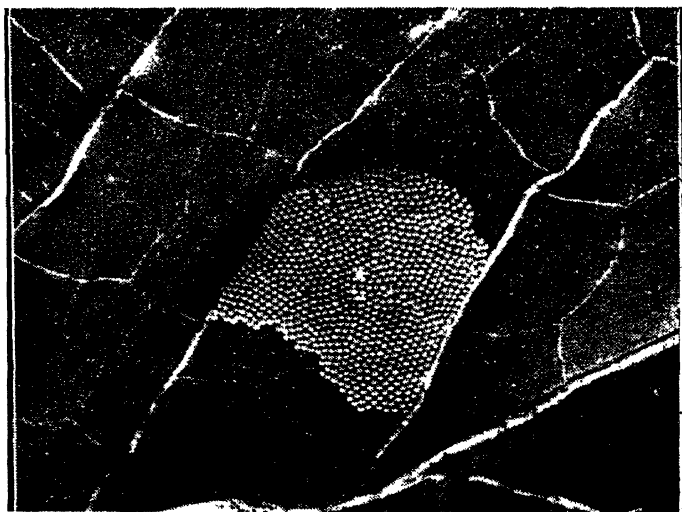
THE COMMON HAIRY CATERPILLAR.

(*Diacrisia obliqua* Wik).

VERNACULAR AND LOCAL NAME.—*Khu, Khu-gaung.*

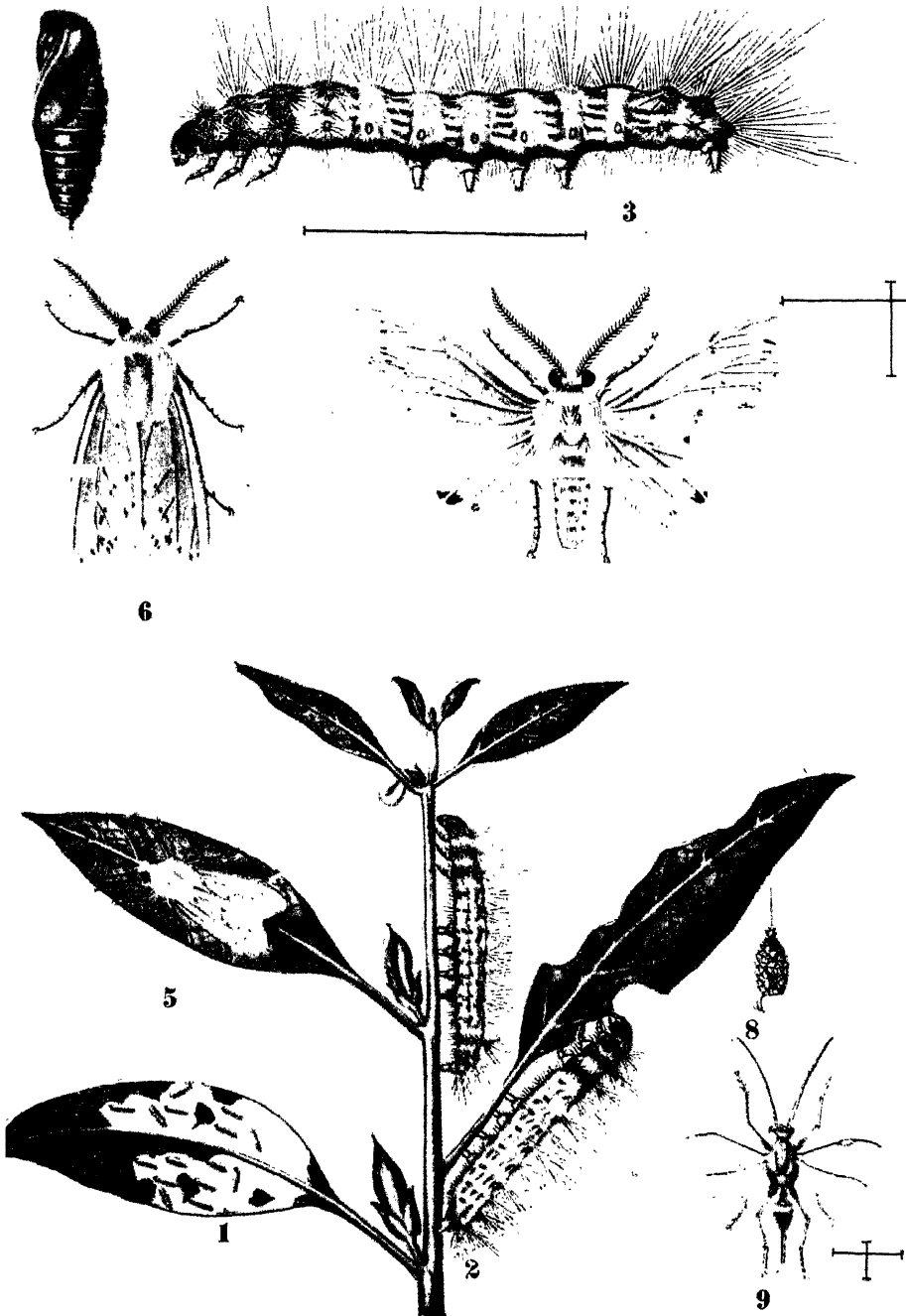
Plate 32.

In some years these yellow-coloured hairy caterpillars (Figs. 2 and 3) cause a lot of damage to beans, sesamum, castor and various other crops by eating away the leaves. After attaining full growth they usually go down to the surface of the earth and there spin cocoons with silk exuded from their mouth. Particles of earth and also the hairs from their own body are woven into the cocoons which are therefore not easily seen. Inside these cocoons they change into pupæ (Fig. 4) and sleep for about 7 to 8 days and then hatch as yellow-coloured moths (Figs. 5, 6 and 7). These moths lay eggs on the leaves and caterpillars hatch from these eggs in about 5 or 6 days, feed, grow and become ready to spin cocoons in the course of about three weeks. Ordinarily the life-cycle is completed in about 35 to 40 days. Some pupæ hibernate for about 7 or 8 months. Each female moth lays about one thousand to twelve hundred small round pearly eggs which are neatly arranged side by side in large clusters on the leaf. (Text Fig. 44).



Text Fig. 44.

EGGS LAID ON LEAF BY THE MOTH OF THE COMMON HAIRY CATERPILLAR.



Common Hairy Caterpillar
(*Diacrisia obliqua*)

Therefore it is quite easy to find these egg clusters if only a man, woman or child looks for them on the plant. The young caterpillars which hatch from so many eggs laid at one place do not disperse but continue to live and feed gregariously for a number of days. They do not bite off entire leaves but nibble their green tissues. Therefore the leaves on which they live and feed look white and transparent (Fig. 1) and are easily noticed simply by looking at the field. When somewhat grown however the caterpillars disperse and feed by biting off leaves entirely.

It is therefore quite clear that the simplest and easiest means is to pluck off the leaves on each of which thousands of eggs or young caterpillars are present and bury them in a pit in the ground. When plucking the leaves with young caterpillars it is better to put these leaves in a vessel about half filled with water to which some kerosene oil has been added ; otherwise many of the caterpillars will drop off if the leaves are carried to any distance. The work is quite simple but what is required is that the cultivator should visit his fields and keep a watch to know when the pest appears. It may appear any time in the year. The attack usually commences with a few moths which come and lay eggs which develop into numerous moths again in a little over a month. Therefore unless the cultivators keep watch over their fields and take the above mentioned simple steps when necessary it is no wonder that widespread damage may occur.

If no caterpillars are found on the white transparent leaves it is certain that they have grown and dispersed in the field. It is advisable to go through the field and dispose of them. The simplest way is to shake the plants on which they may be feeding. They let go their hold and drop on the ground where they can be cut or beaten with a stick or crushed under foot.

These hairy caterpillars are practically omnivorous and may be feeding and breeding on many wild plants. Therefore it is advisable to look for them occasionally in the jungle if there be any in the neighbourhood.

If there be any objection to crushing or burying the caterpillars or egg clusters they may be put in kerosenised water for several days and then thrown away.

CUT-WORMS.

(*Agrotis ypsilon* Rott.; with it *Agrotis flammata* Schiff, and *Euxoa segetum* Schiff. are also known to occur.)

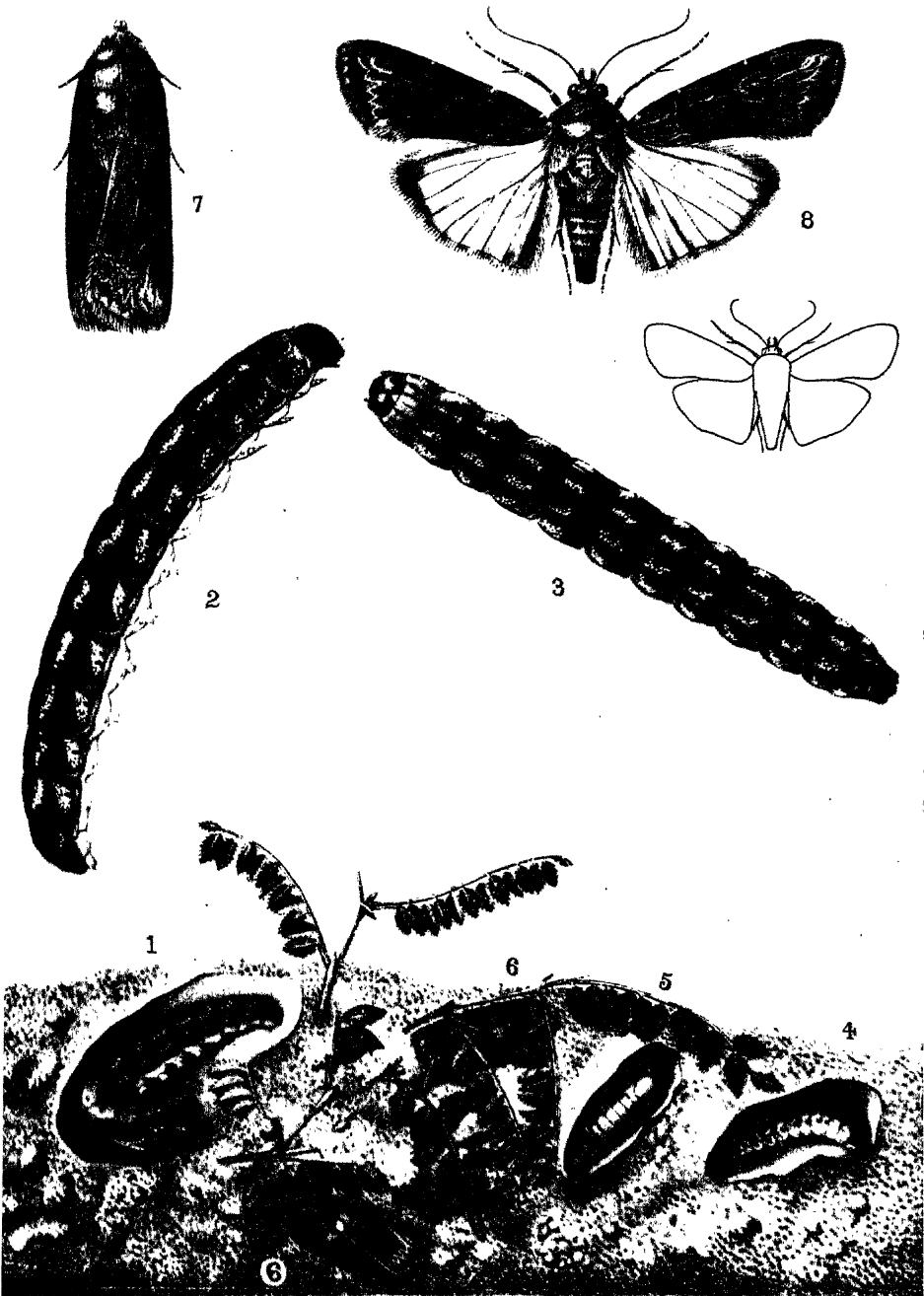
VERNACULAR AND LOCAL NAMES.—*Nga-myaung-daung*; *Daung-de* on tobacco (Sa-aing); *Po-than-gyaung*, i.e., iron rod insect (Thayetmyo); *Po-naga*, i.e., dragon like insect and *Pyat-fo*, i.e., cutting insect (Minbu).

Plate 33.

This is a cold weather pest in the plains appearing about September-October and disappearing about March-April. The rest of the year is believed to be passed by it under milder conditions in the hills. Sporadic caterpillars may occur anywhere. But the pest occurs in epidemic form in areas which are submerged in the rainy season and are brought under cultivation as the water recedes. Extensive regions, commonly known as *kyun* lands, in the beds of the Irrawaddy and other rivers, growing excellent winter crops, suffer almost regularly from this pest, in some years severely and in other years less. The pest has also been known to occur in epidemic numbers in areas which are not submerged as a rule but has been flooded once in a way. There is something in such flooded regions which attracts the moths (Figs. 6, 7 and 8) which therefore congregate there. As each moth is capable of laying up to about 2,000 eggs the pest is capable of very severe damage. The caterpillars while young feed generally on leaves. When somewhat grown they have the habit of cutting off the plants near the base thus causing more damage than necessary for their food. They are nocturnal in habit and remain hiding under the soil during the day time. A single caterpillar usually cuts several plants in the course of its larval life. Fig. 1 shows a caterpillar near a cut gram plant exposed and 2 and 3 enlarged giving side and back views. When fullgrown it prepares a sort of cell in the earth (Fig. 4), contracts the body and then transforms into pupa (Fig. 5). Moths remain hiding during the day time under shelter (Fig. 6), even coming into houses for the purpose. The life-cycle occupies about seven weeks, *viz.*, eggs three to five days, larva about 30 days and pupa ten days. Therefore there may be about two to three generations in the plains.

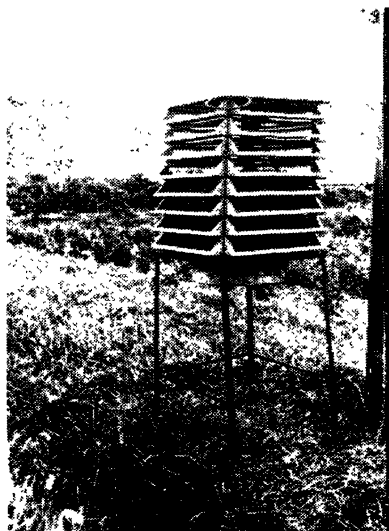
The caterpillars are practically omnivorous and eat any plants. But tobacco, potato and gram usually suffer most. Beans also may suffer.

Control.—The pest is known to cause damage in other countries also. In Egypt a trap (Text Fig. 45) has been devised, known as Andre Maire trap, which is baited with an aromatic bait composed of methyl acetate and molasses or fermented toddy and molasses and traps the moths as they are attracted by the bait at night. The trap has been used with success in Mekameh Tal lands in Bihar against this pest. Traps are set up early in the season about September and worked for sometime to catch the moths as they appear and before they lay eggs. Some moths fail to get into the traps and there is an attack near about them and it is necessary to keep watch and pick out the caterpillars. The crop over the whole region is saved. It is necessary to make use of the traps every year. For this purpose a regular organization among



Cutworm
(*Agrotis ypsilon*)

the cultivators is necessary.



Text Fig. 45.

ANDRE MAIRE TRAP.

The use of traps would be very effective but is hardly practicable in the absence of a proper organization and unless a large area is concerned. At present the only thing practicable is to weed out the caterpillars which are easily found in the soil near cut plants. This should be carried out systematically and is more effective than the use of a poisoned bait sometimes recommended.

Sometimes the caterpillars behave, after darkness sets in, like ordinary caterpillars climbing upon plants and eating leaves. Collection would be easier at this time with the help of a light.

THE EPILACHNA BEETLES.

[*Epilachna dodecastigma* Muls. (12-spotted) and *E. vigintioctopunctata* Fb. (28-spotted.)]

Plate 67, Figs. 10-12.

The EPILACHNA beetles and their spiny grubs sometimes occur on cow-pea leaves and unless controlled in time much damage may be done, as the beetles breed largely. The mode of feeding and breeding is the same as described under brinjal (page 141).

The leaves with the grubs require to be picked off and destroyed. The egg-clusters are easily disposed of if crushed with the fingers.

If many beetles are present they should be caught with hand nets. If many grubs appear in a scattered manner they can be sprayed with strong rosin compound solution.

THE GREEN SEMILOOPER.

(*Plusia orichalcea* Fb.)

Plate 34.

This caterpillar (Figs. 1 and 2) walks with a somewhat looping gait forming about half a loop with the body. Caterpillars with this gait are known as semiloopers. This green semilooper occurs on gram, peas, linseed and other crops and eats leaves. When fullgrown it forms a cocoon on the plants by webbing some leaves together and transforms into a pupa (Fig. 3) inside this cocoon and ultimately issues as a moth (Figs. 5 and 6 in sitting and flying postures). The moth lays eggs on the plant and the semiloopers hatch out of these eggs. The life-cycle takes about five weeks, *viz.*, egg four to five days, semilooper about four weeks and pupa about a week.

This moth has beautiful large golden patches on its front wings. Moths with wings wholly dark gray develop from similarly looking green semiloopers which feed on the same and several other plants.

The semiloopers should be picked off with hand.

THE GRAM POD BORER.

(*Heliothis obsoleta* Fb.)

Plate 35.

This caterpillar (Figs. 2 to 5) as shown in the plate bites a hole in the pod, thrusts its head in and eats the seeds. It eats seeds in pigeon pea (*pesinngon*) pods and also sometimes tobacco capsules in the same way. Occasionally it occurs on and bites into maize cobs. When full grown it descends to the ground, makes a cell in the earth (Fig. 6) and transforms into a pupa. The moth (Figs. 7 and 8) emerges from the pupa and lays eggs (Fig. 1 enlarged) from which the caterpillars hatch out. Young caterpillars eat leaves but with growth develop the boring habit. The life-cycle takes about five weeks, *viz.*, egg about four days, caterpillar about two to three weeks and pupa about a week.

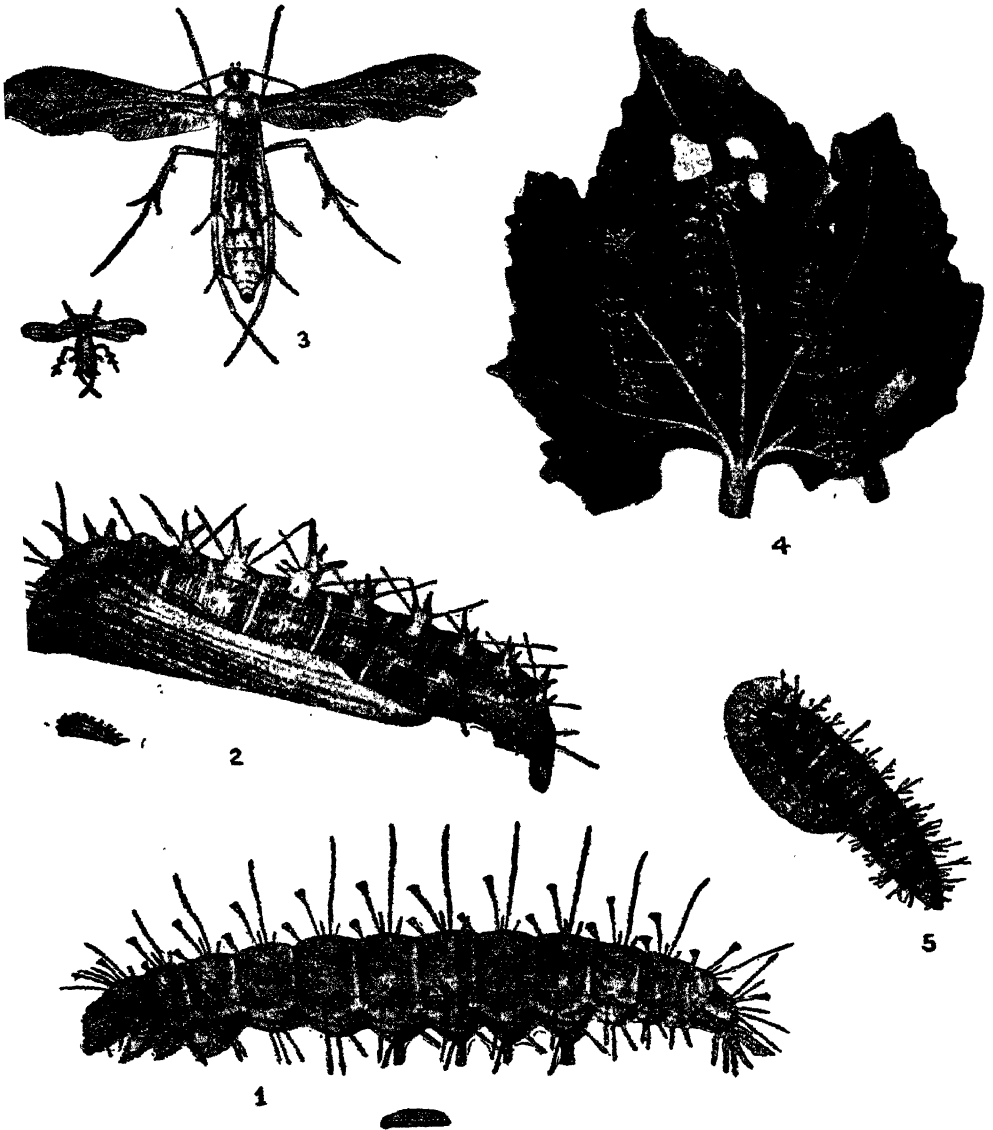
Hardly anything else is possible or efficacious beyond going through the fields of gram and *pesinngon* when pods form and picking off the caterpillars which on account of their size are easily visible. Unless picked off a single caterpillar bores several pods.



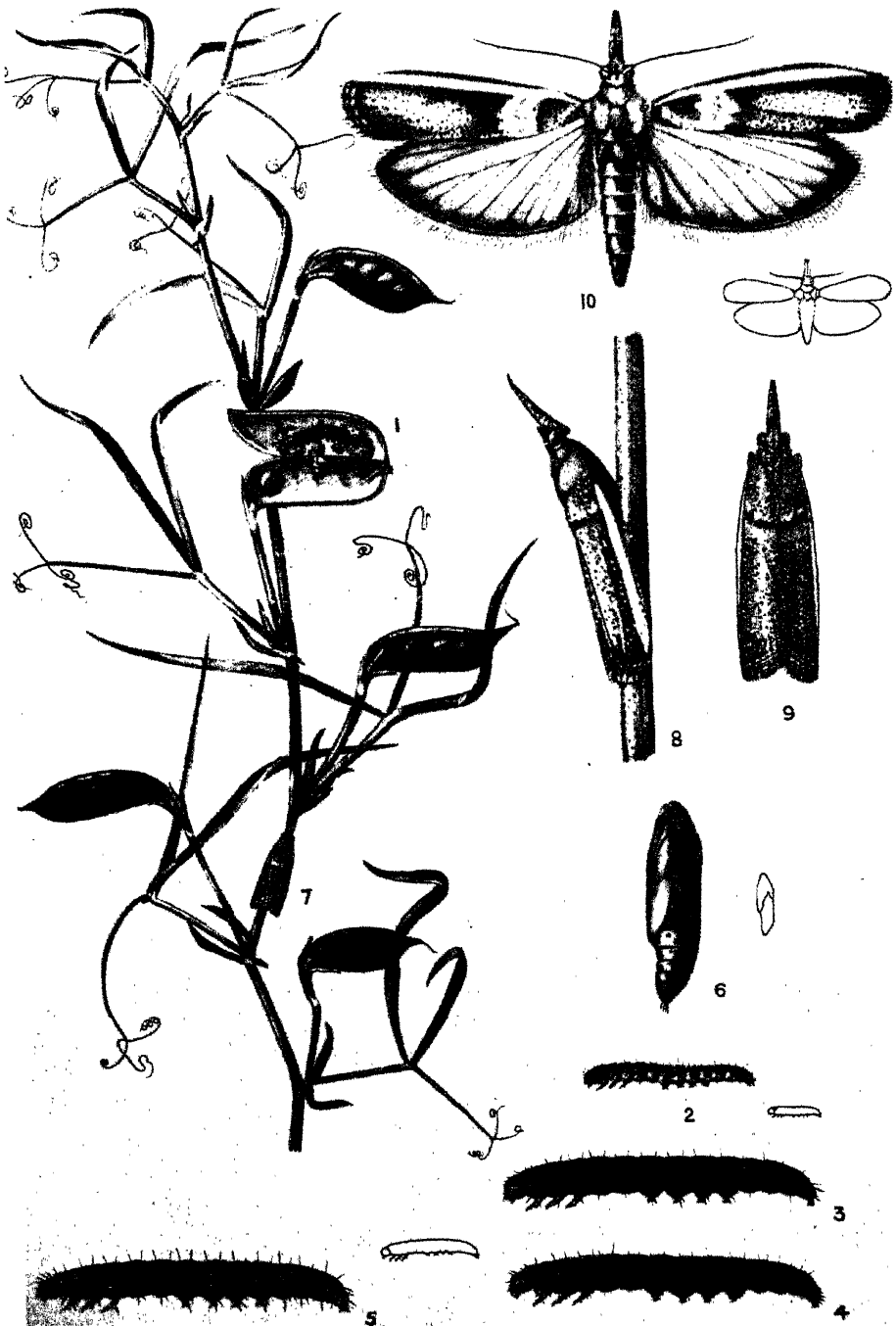
The Green Semilooper
(*Plusia orichalcea*)



Gram Pod-borer
(*Heliothis obsoleta*)



PLUME MOTH (*Sphenarches caffer*).



Snouted Moth Pod-borer
(*Etiella zinckenella*)

PLUME MOTH CATERPILLAR.

(*Sphenarches caffer* Z. *Exelastis atomosa* also occurs.)

Plate 36.

The small spiny green or brown coloured caterpillars (Fig. 1 and the two on the right hand side on Fig. 4) occur on the pods of pigeon peas and also of the *lablab* group of beans biting into the pods and eating the seeds. They also occur on the leaves of bottlegourds biting holes in the leaf. When full-grown they attach the hind end to silken filaments previously applied to the surface of the pods or leaves and transform into pupae (Fig. 2 and the one on the lefthand side on Fig. 4). Moths emerge from the pupae. Fig. 3 shows a moth in typical sitting posture. Its hind wings are divided into plumes and hence the common name. Moths lay eggs a few of which are shown on Fig. 4. The caterpillars hatch from these eggs. The life-cycle ordinarily takes about four weeks, *viz.*, egg two to three days, larva 18 to 20 days and pupa five days.

Figure 5 shows a parasitised caterpillar killed by the parasitic grub which has fed inside its body and has now come out to pupate.

As a rule these caterpillars do not occur in large numbers and hardly any measures are necessary or practicable.

THE SNOUTED MOTH POD-BORER.

(*Etiella zinckenella* Tr.)

Plate 37.

Figure 1 in the plate shows in an opened pod of chickling vetch (*Pe-chinboun*—*Lathyrus sativus*) how the caterpillar eats the seeds inside. The colour of the caterpillar varies as illustrated in figures 2 to 5. When fullgrown the caterpillar leaves the pod and forms a sort of cocoon on the ground with webbed up debris and transforms into a pupa (Fig. 6) inside the cocoon. The moth (Figs. 7 to 10 in sitting and flying postures) emerges from the pupa and exhibits a long snout on the head. The caterpillars hatch from eggs deposited by the moth and bore into pods as described and illustrated.

Pechinboun is the crop on which it occurs in large numbers. It also occurs in pea, pigeon pea and sunn hemp pods and may occasionally occur in other kinds of pods but not in injurious numbers.

Hardly anything can be done to prevent damage. But when these crops are harvested and heaped at one place the caterpillars are found leaving the pods and walking away in search of shelters for pupation. In order to reduce the number and prevent increase they should be swept up and destroyed.

THE HAIR STREAK BUTTERFLY POD-BORER.

(*Euchrysops cnejus* Fb.)

Plate 38.

There is another almost similar butterfly, *Polyommatus beaticus* L. whose caterpillar also occurs as a pest in the same way especially on pigeon peas.

This slug-like caterpillar (Figs. 3, 4 and 5) bores into flower buds and pods of black and green grams (*matpe* and *pedisein*) and also of pigeon peas and may occasionally occur on other beans. The butterfly (Fig. 7 in flying and Fig. 8 in sitting postures) lays white sculptured small flattened disc-like eggs on shoots, flower buds and pods (Fig. 1 and 2 is an egg enlarged). The caterpillar hatching out of this egg feeds and grows, damaging several buds and pods and when fullgrown transforms into pupa (Fig. 6) on the plant. The butterfly develops from this pupa. The life cycle ordinarily takes about three weeks, viz., egg about 3 days, larva 12 days and pupa 7 days. The periods are lengthened in the cold weather.

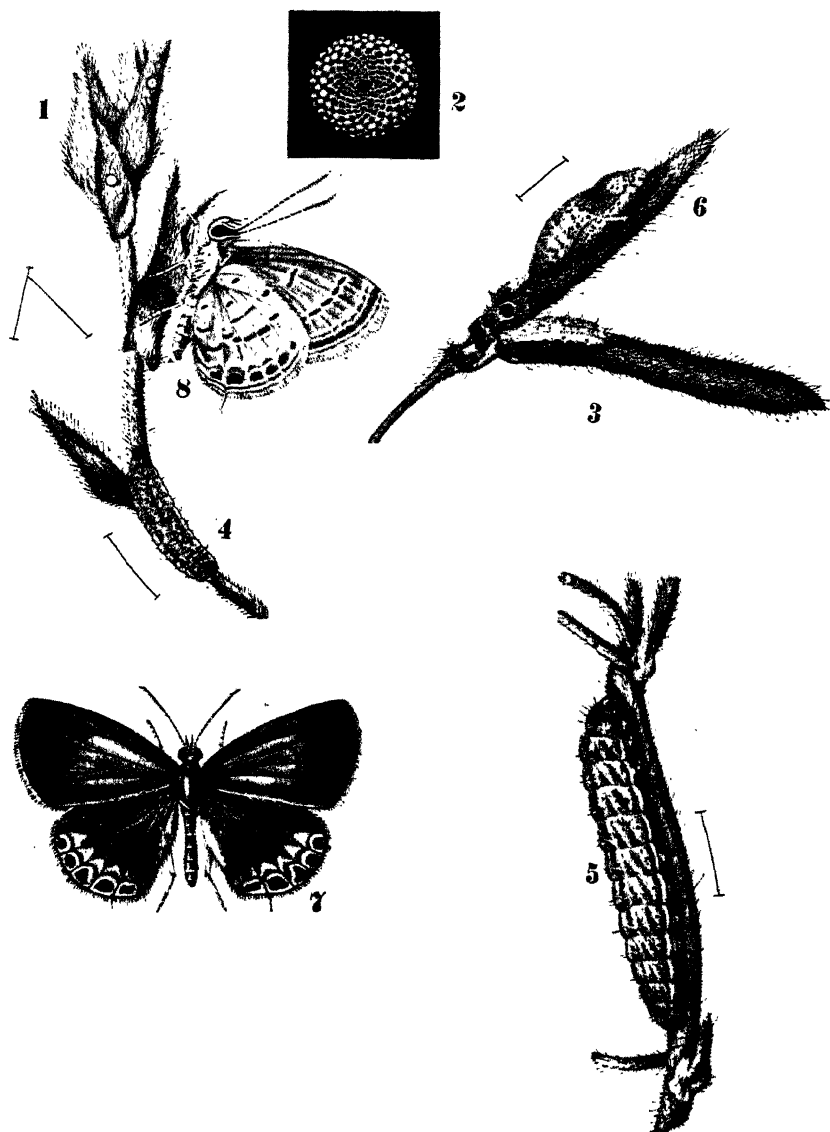
Butterflies are seen flying about and depositing eggs and may be caught in hand nets. If one takes the trouble caterpillars can be picked off.

THE SPOTTED POD BORER CATERPILLAR.

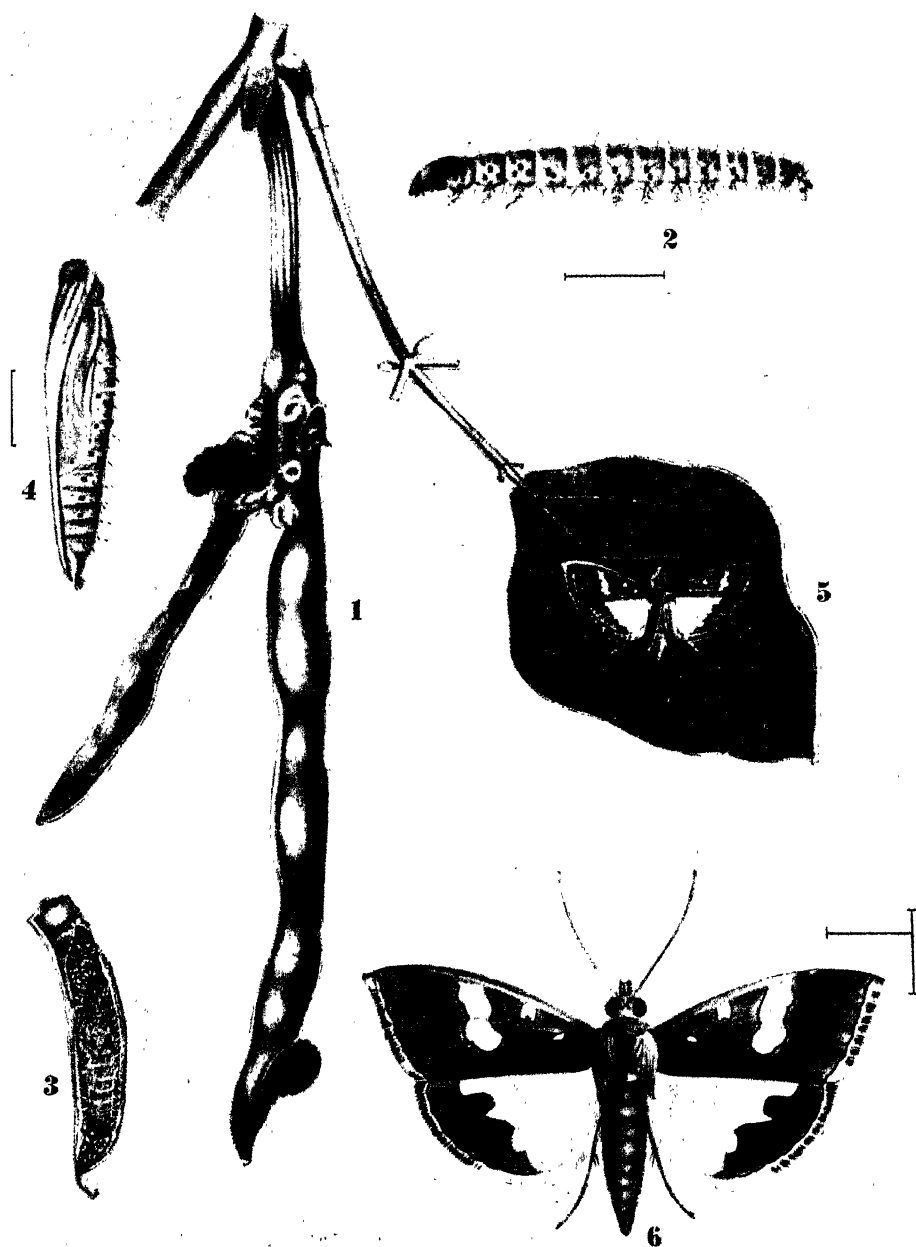
(*Maruca testulalis* Geyer.)

Plate 39.

This spotted caterpillar (Fig. 2) bores into pods and eats the seeds of black gram (*matpe*), green gram (*Phaseolus mungo*), cowpeas and pigeon peas and may occasionally occur on pods of other beans too (Figs. 1 and 3). In some years it occurs in large numbers and webs up entire flower heads and eats the flower buds of pigeon peas and in this way causes more harm than by boring into pods. When fullfed and



Hair-streak Butterfly Pod-borer
(*Catochrysops cnejus*)



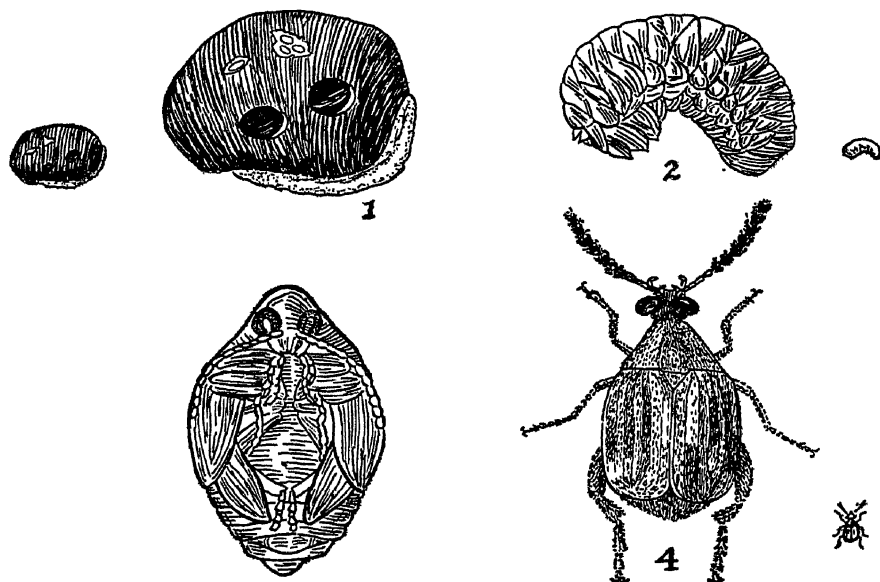
The Spotted Pod-borer
(*Maruca testulalis*)

fullgrown it transforms into a pupa (Fig. 4) inside the webbings and bored pods. The moth with prominent white spots (Figs. 5 and 6) is seen flying about even during the day time and laying eggs on the plants. The caterpillars hatch from these eggs. The life-cycle occupies about four to five weeks.

Destruction of webbed up flower heads or of bored pods which can be recognized by the frass thrown out, can be carried out in order to check its increase. The moths may also be caught in hand nets.

THE *PHASEOLI* PULSE BEETLE

(*Bruchus phaseoli* Gyll.)



Text Fig. 46.

THE *phaseoli* PULSE BEETLE (*Bruchus phaseoli*).

1. EGGS ON A BEAN SEED WHICH ALSO SHOWS EXIT HOLES OF THE BEETLE,
2. GRUB, 3. PUPA, 4. BEETLE. (AFTER FLETCHER AND GHOSH.)

This pulse beetle attacks the pods of the *pegyi* or *lablab* group of beans in the field. Pale yellow coloured eggs are deposited in small

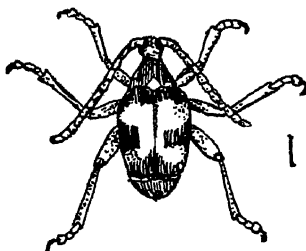
clusters on the green pods, each cluster containing up to about 8 or 10 eggs. There may be several clusters on the same pod. The grubs on hatching bore into the seeds inside the pods and feed on the contents of the seeds, pupate there and on attaining the adult state issue through holes bitten in the seeds. The seeds are usually harvested with the grubs inside them and stored and very soon holes appear in them as the beetles develop and emerge. This is a common complaint against the large white Rangoon bean (*Pegyi—Dolichos lablab*) the export of which is seriously interfered with for this reason. Further, the beetles after emergence in the store continue breeding there and cover the seeds with speck-like white eggs (Text Fig. 94). Seeds which escape damage in the field are thus damaged in the store and very serious loss occurs as a consequence. Many beetles, up to a dozen or more may breed out of a single seed which thus loses practically all the farinaceous substance. Ordinarily the life-cycle occupies about three to four weeks. Each female beetle lays about 70 to 140 eggs in the course of her life.

It is not possible to prevent infection of pods and seeds in the field. But there is a simple method of separating infected from uninfected seeds at the harvesting time. If the seeds are steeped in cold water for about $1\frac{1}{2}$ to 2 hours the infected ones swell. The swollen seeds should be picked out and separated. The infected and uninfected seeds should be dried thoroughly after steeping and separation and before storage. If the seeds are spread out in thin layers and sunned for several days many of the grubs feeding inside are killed off. The seeds should get heated for this purpose. The infected ones should be used up first.

In some places the seeds are parched over a fire and eaten. Parching or frying over fire kills the insects which may be present inside and if the seeds are parched soon after harvest no steeping in water is necessary. The swollen seeds separated after steeping may be parched and stored and no holes will appear in them.

As regards storage, precaution has to be taken against access of the beetle from outside. The simplest method is to store the seeds in a jar or other vessel which will not allow access of the beetle through cracks or openings at the sides or bottom. On the top a piece of muslin may be spread and the mouth of the vessel filled with dry sand so as to have a layer of about two inches of sand above the seeds. It would be advisable to examine the seeds once about three weeks to a month after storage. Some infected seeds may be present and the beetles issuing out of them may infect other seeds.

THE ANALIS PULSE BEETLE.

(Bruchus analis, F.)

Text Fig. 47.

Analis PULSE BEETLE (*Bruchus analis*).

The life-history and habits of this pulse beetle are almost similar to those of the *phaseoli* pulse beetle but eggs are laid singly. The grub feeds in the same way and the beetle too finds its way into the store with harvested seeds and continues to breed on dry seeds there in the same way. But although there may be many eggs laid on a seed usually only one grub develops in it and only one beetle breeds out of one seed. In ordinary temperature the life-cycle takes about three to four weeks and each female lays up to about 100 eggs.

In the field this beetle occurs mostly on *pedisein* (*Phaseolus radiatus*) and all varieties of cowpeas.

The seeds should be thoroughly dried in the sun for several days in thin layers so that all the seeds may get heated. This kills the majority of the grubs feeding inside them. The seeds should then be stored under a layer of dry sand.

THE CHINENSIS PULSE BEETLE.

(Bruchus chinensis L.)

Plate 84, Figs. 1 and 2.

This beetle occurs in the field as a pest on pigeon peas, eggs being laid on pods singly and the grubs boring into and feeding on the contents of the seeds. If the grubs pupate and attain the adult state before the pods are harvested the beetles emerge by biting holes in the seed as well as in the pod. The life-history is similar to that of the *phaseoli* and *analis* pulse beetles but the *chinensis* beetle usually does greater damage in the field than the other two and like them

continues damage in the store by breeding on dry seeds. Like the *phaseoli* beetle several *chinensis* beetles breed in one seed. The life-cycle occupies about three weeks in ordinary temperature. Each female beetle lays about 50 eggs in the course of her life. Adult beetles are found visiting flowers and eating pollen. The beetle breeds in a few other peas and beans in the field but not on such an injurious scale as on pigeon peas.

It is advisable to grow resistant varieties of pigeon peas. At harvesting time the seeds should be thoroughly sunned for several days in thin layers so that they may get thoroughly heated. Seeds having white speck-like eggs on them are better not stored but used up. If they are parched and fried they can be stored after frying. The seeds are best stored under a layer of dry sand in vessels not allowing access to the beetles through cracks and holes at the sides or bottom.

Another beetle, *Bruchus albocollus*, attacks pigeon pea seeds in pods in the field but not on an injurious scale and it is not known to breed in the store. Therefore it is not of much importance as a pest.

THE GREEN BUG.

(*Nezara viridula* L.)

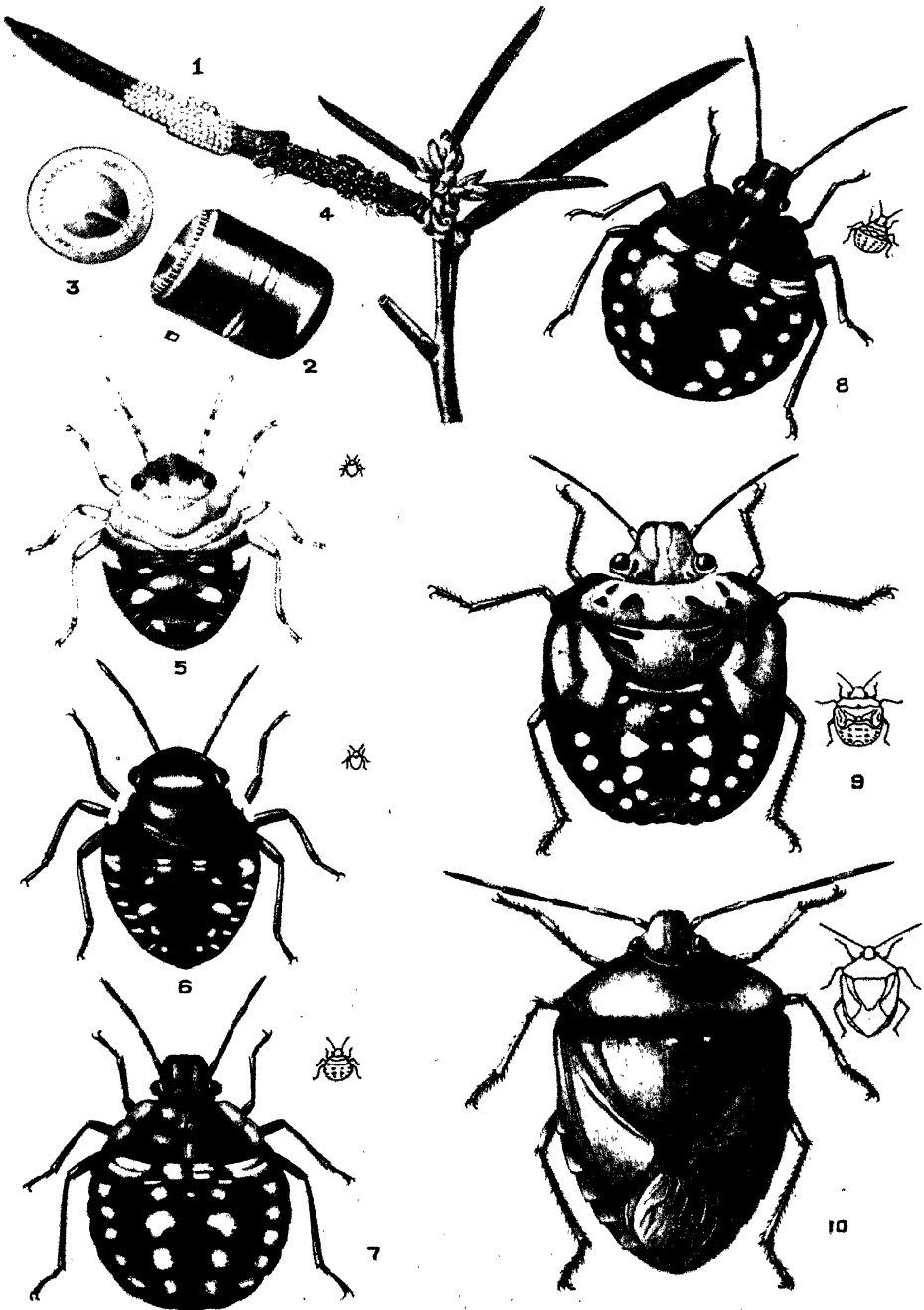
Plate 40.

The life-history of this bug is typical of several kinds of bugs of various sizes and colours which occur on peas and beans. As both young and adult bugs suck plant juice throughout their life when they occur in large numbers the plants, although showing no apparent outward damage, may suffer badly from loss of sap.

Figure 1 shows how eggs are deposited in clusters. Each cluster may contain about 40 to 100 eggs which hatch in about a week. Figs. 2 and 3 show one egg enlarged and the sculpture on its top respectively. The colour changes before hatching. Fig. 4 shows how the newly hatched young nymphs sit and feed gregariously. They gradually grow, casting off skins at intervals and developing wing pads. Figs. 5 to 9 show the various stages of growth. With the fifth casting off of the skin the bug appears as the fullgrown adult (Fig. 10) in the course of about three weeks, capable of flying from plant to plant and from place to place. Adult bugs live for about two months and each female lays about 300 to 350 eggs.

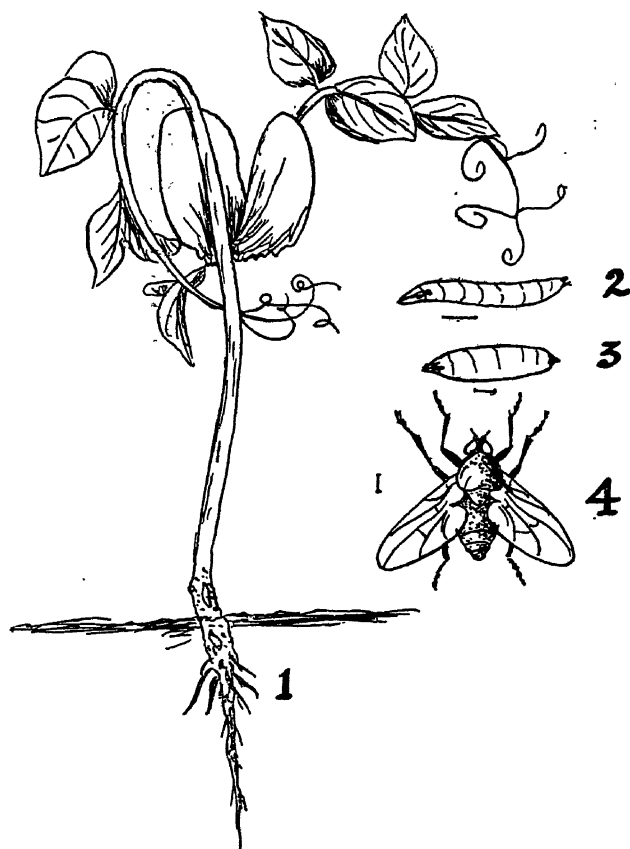
This bug occurs on potato plants also.

It is necessary to destroy egg clusters in time and to shake off the nymphs and also adults when sitting gregariously into pots containing water and kerosene oil.



The Green Bug
(*Nezara viridula*)

THE BEAN STEM FLY.

(Agromyza phaseoli Coq.)

Text Fig. 48.

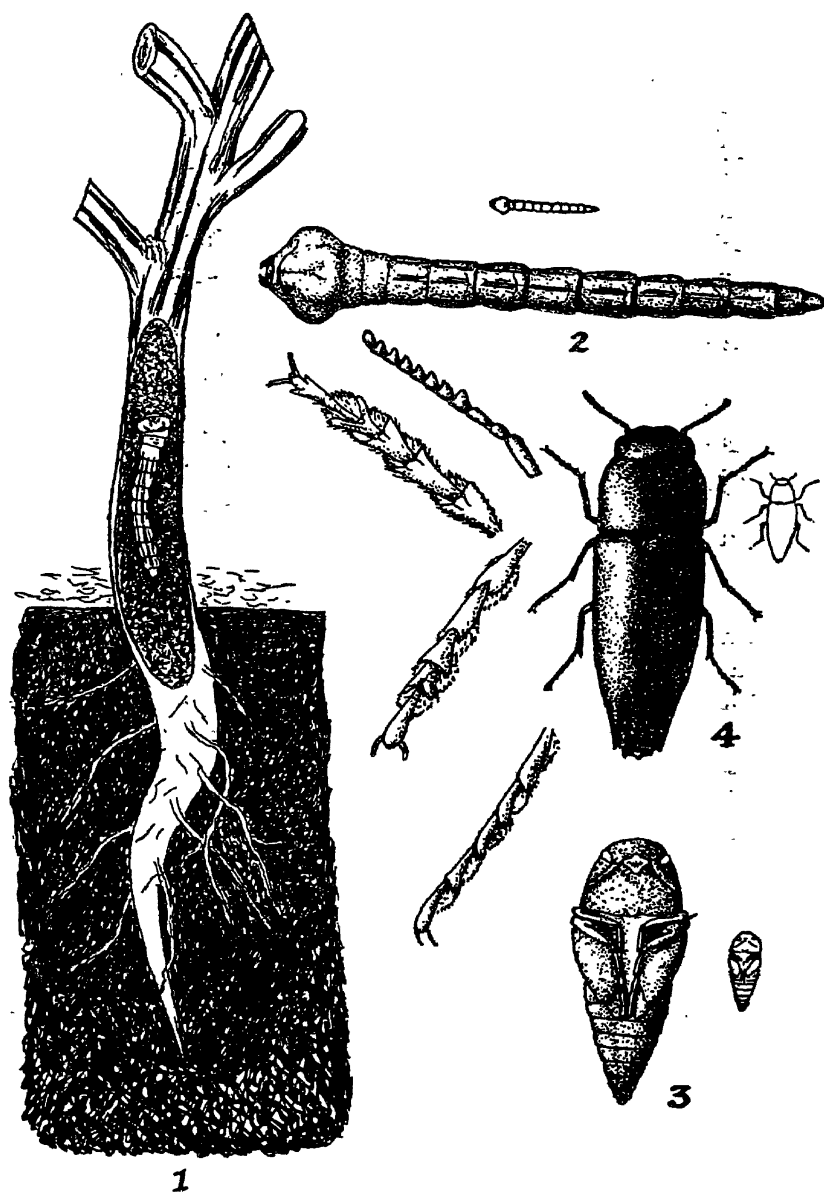
THE BEAN STEM FLY.

1. INFESTED PEA SEEDLING, 2. MAGGOT, 3. PUPARIUM, 4. FLY.

This fly deposits eggs on the stem of pea and bean seedlings near the soil surface. The maggots which hatch from these eggs bore the tissues upwards into the stem and also downwards into the root causing the seedlings to wilt and dry. The maggots pupate in the stem and soon emerge as flies. The plants are hardly affected if there be only one or two maggots in them but usually there are about half a dozen or more maggots boring in individual stems and the plants succumb to their attack. Certain kinds of beans, for example, *pey-in* (*Phaseolus calcaratus*) seem to be more liable to damage than others.

The fly has been observed to be present and to infest plants all the time between August and February. Various strong smelling repellents have been tried but have hardly any effect. The following two measures have proved effective in minimising the damage. The best measure is to give the plants conditions which enable them to grow vigorously. This should be combined with pulling out with the roots and burning all wilted and drying plants systematically as soon as wilting takes place. When wilting takes place it is certain that there are many maggots in it which will soon turn into flies to infest other plants.

BEAN STEM BORER BEETLE.

(Hoplistura ghoshi Thery.)

Text Fig. 49.

BEAN STEM BORER BEETLE (*Hoplistura ghoshi*).

1. GRUB IN STEM, 2. GRUB, 3. PUPA, 4. BEETLE.

An elongated legless white grub with expanded thorax bores the stem of beans, but only occasionally. One year about fifty per cent of *peyin* (*Phaseolus vulgaris*) suffered at the Mandalay farm. The grub pupates in the tunnel in the stem and issues out on attaining the adult state. Details of the life-history are not known.

Hardly anything else is possible beyond pulling out and burning the affected plants with grubs in order to prevent multiplication.

MINOR PESTS ON PEAS AND BEANS.

The Sesamum Sphingid Caterpillar (Plate 51) occasionally occurs on *pegyi* and eats leaves. Other leaf eating caterpillars observed are the Linseed Caterpillar (Plate 58) on peas, *Cacæcia* sp. on horse gram and *Lemprosema indicata* on black gram (*matpe*).

A few leaf-miners producing white blotches on leaves have been observed but do not cause appreciable damage, viz., *Stomopteryx nerteria* and *S. subsecivella* Zell. on soy beans and *Acrocercops cærulea* Meyr. on *matpe*, *pedisein*, *pegyi* and *pegadiba* (*P. lunatus*).

The sesamum top-leaf roller (Plate 52) once occurred on green gram flowers.

Pigeon pea pods harbour one small fly maggot allied to the Bean Stem fly (Text Fig. 48) which bores the seed. A small caterpillar bright red in colour when fullgrown and allied to the sunnhemp stem borer (Plate 42) has been observed to occur in small numbers in pods of cowpeas, lima beans and *Phaseolus calcaratus*, eating seeds.

Several bugs (*Cyclopelta*, *Riptortus* and Membracids) occasionally occur but mostly on pigeon peas.

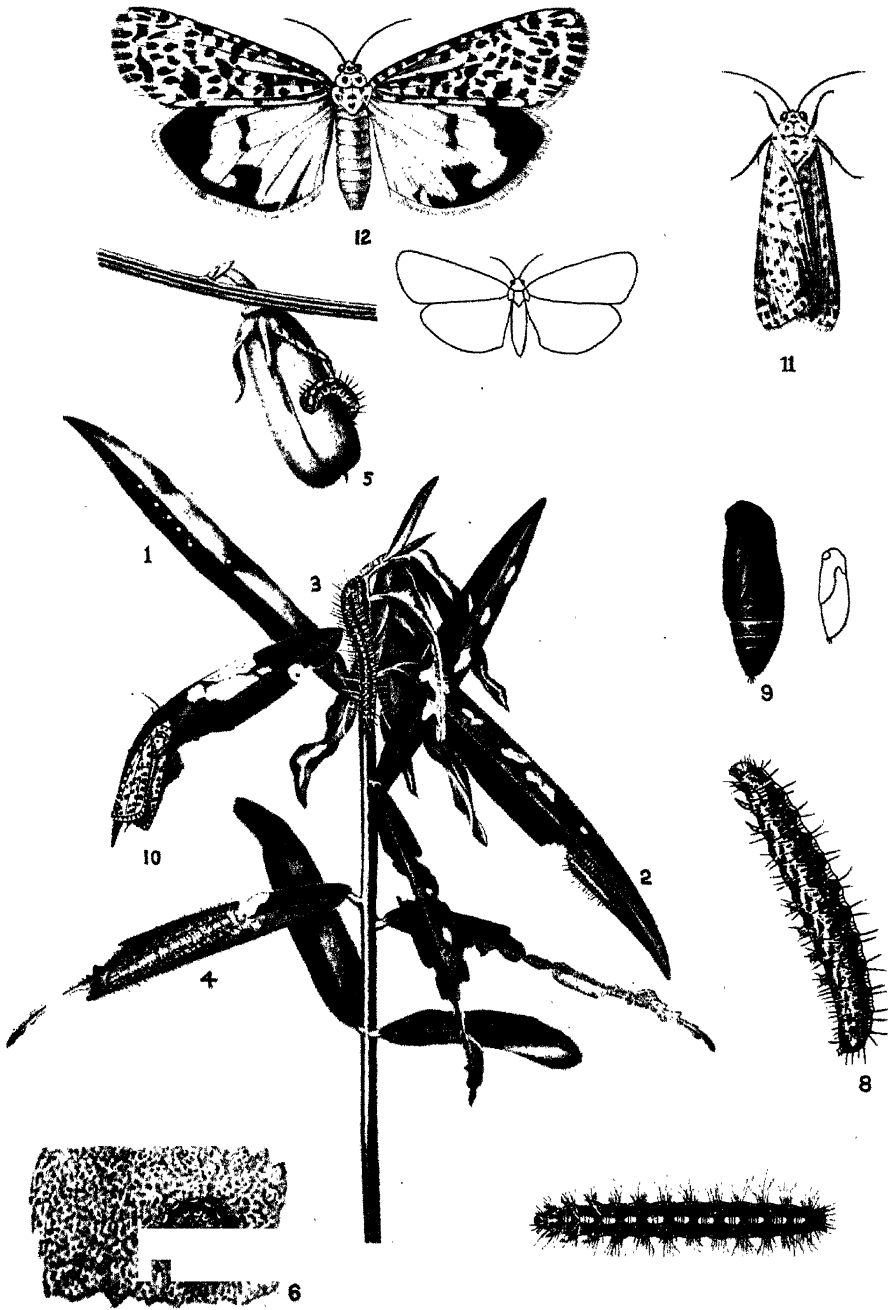
PESTS ON SUNNHEMP.

SUNNHEMP HAIRY CATERPILLAR.

(*Utetheisa pulchella* Linn.)

Plate 41.

These hairy caterpillars (Figs. 2 to 8) are a pest on sunnhemp. They eat leaves and also bore pods, the seeds of which are eaten. It is however the young plants which really suffer. When fullgrown the caterpillars go down to the ground and form cocoons by binding debris and particles of earth, transform into pupæ (Fig. 9) and ultimately issue as moths (Figs. 10 to 12). The prominently coloured moths are observed flying about during the day time and laying eggs (Fig. 1) on leaves. The caterpillars hatch from these eggs. Ordinarily the life-cycle is completed in about three to four weeks, viz., eggs 3 to 4 days, larva 10 to 15 days and pupa 6 to 7 days. Each female moth lays about 300 to 400 eggs.



Sunn-hemp Hairy Caterpillar
(*Utetheisa pulchella*)



Sunn-hemp Stem-borer
(*Laspeyresia pseudonectis*)

The caterpillars are rather sensitive and when the plants are shaken they coil up their body and drop on the ground (Fig. 6). They can be caught by brushing the young plants with hand nets and the moths which fly sluggishly can also be captured easily in hand nets.

SUNNHEMP STEM BORER.

(*Laspeyresia pseudonectis* Meyr.)

Plate 42.

A small caterpillar (Fig. 3) which assumes a bright red colour when fullgrown (Fig. 4) bores the stem causing a swelling at that place (Fig. 1). On being fullgrown it transforms into a pupa (Fig. 5) inside the gall. When the moth is ready to emerge the pupa wriggles out of the pupal cell in the gall through a hole provided by the caterpillar before pupation. The moth (Fig. 6 in sitting and Fig. 7 in flying postures) lays eggs on the plant and the caterpillars hatch out of these eggs and bore into the stem.

Galls are more often formed at the growing tops and in that case further growth of the plant is stopped. The fibres break at the galls formed in the middle of the stem.

In order to prevent the pest from increasing in number galls at the tops of young plants should be cut off and either buried underground or burnt.

PESTS ON COTTON.

There are many pests on cotton plants but the indigenous *wagyi* and *wagale* varieties of cotton show a great resistance to all of them and do not suffer in the same way as the introduced Cambodia and other varieties.

The seedling plants may be cut by cockchafer grubs (*podigaung*—Plate 7) and the large brown cricket (*payit*—Plate 3). If, however, the land is well ploughed and prepared and no grass or weeds are allowed to be present in it sometime before planting there is hardly any likelihood of trouble from either of these insects.

The plants may suffer from thrips, jassid bugs, mites and aphids at any but especially in the early stage. All of these occur on the leaves, usually in unfavourable seasons but can be controlled with spraying if one is prepared to undertake a little work and expense. The methods have been described under general pests.

The top leaves may be rolled together and dry due to the activities of the top-leaf or bud roller. Leaves, especially of broad-leaved varieties like Cambodia are rolled by the Leaf Roller. There are a few leaf-eating caterpillars which however have never been observed to occur in injurious numbers. Shoots wilt and droop due to the boring by the Spotted Bollworm and in some cases by the shoot borer weevil.

The flower buds and bolls are bored by the Spotted and Pink Bollworms. Green bolls are sucked by the Red Cotton Bug and mature open ones by the Dusky Cotton Bug.

Two mealy bugs occur, a white one on shoots and a spiny brown one on stems, the latter being bad.

The grubs of two beetles bore the stem, but none of them has so far occurred in injurious numbers.

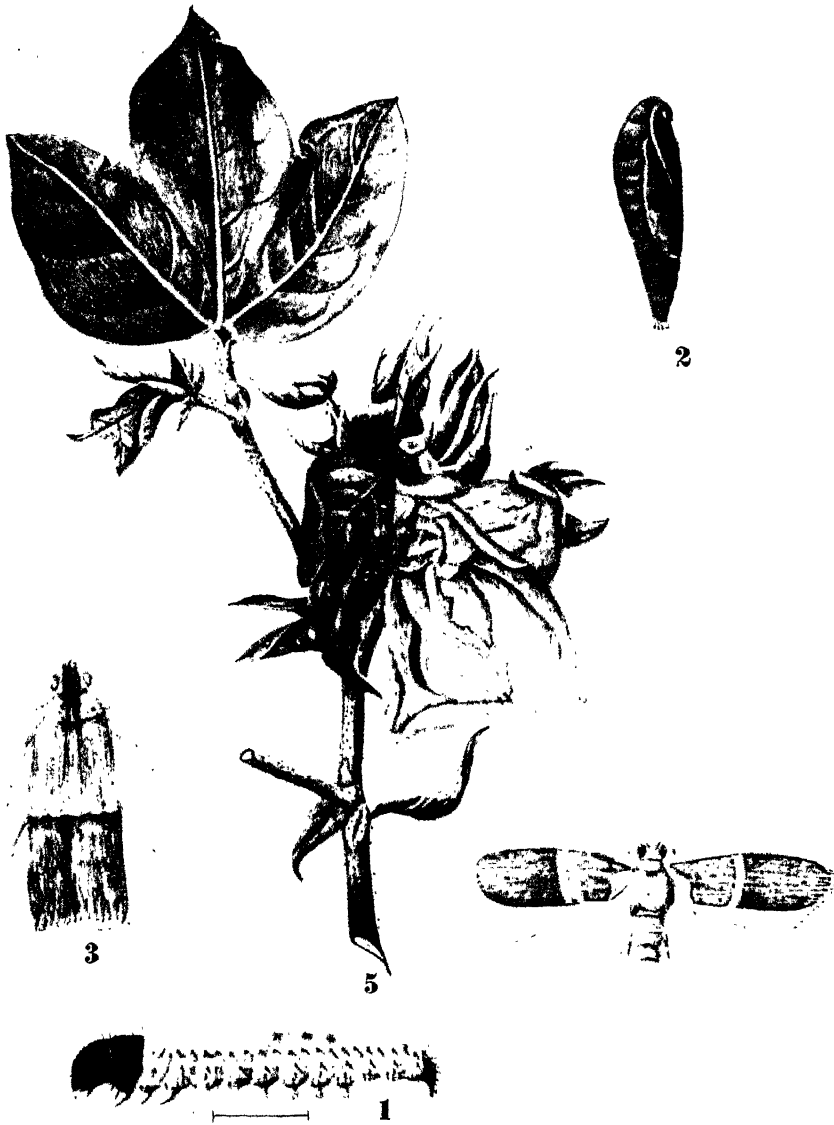
THE TOP-LEAF OR BUD ROLLER.

(*Phycita infusella* Meyr.)

Plate 43.

This caterpillar (Fig. 1) rolls the leaves at the growing bud of the plants (Fig. 5) causing them to dry. The rolled dry buds are easily noticed. When fullgrown the caterpillar transforms into pupa (Fig. 2) inside the rolled bud and ultimately issues as a moth (Figs. 3 and 4). The moth lays eggs from which the caterpillars hatch.

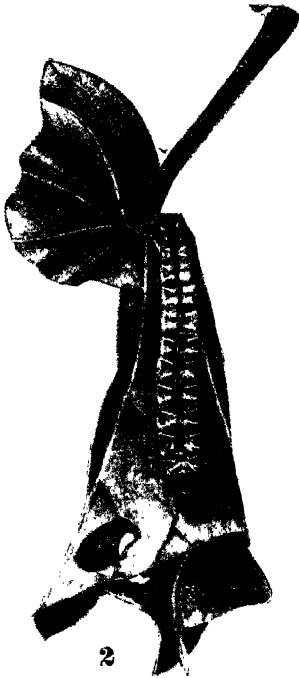
The rolled top shoots should be cut off and burnt.



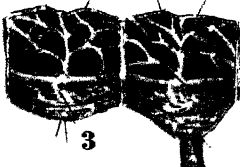
Cotton Top-leaf roller
(*Phycita infusella*)



5



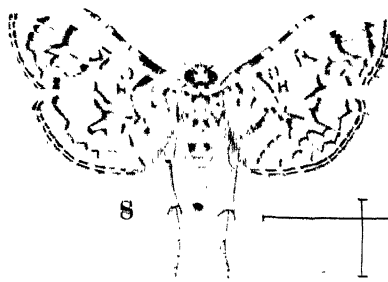
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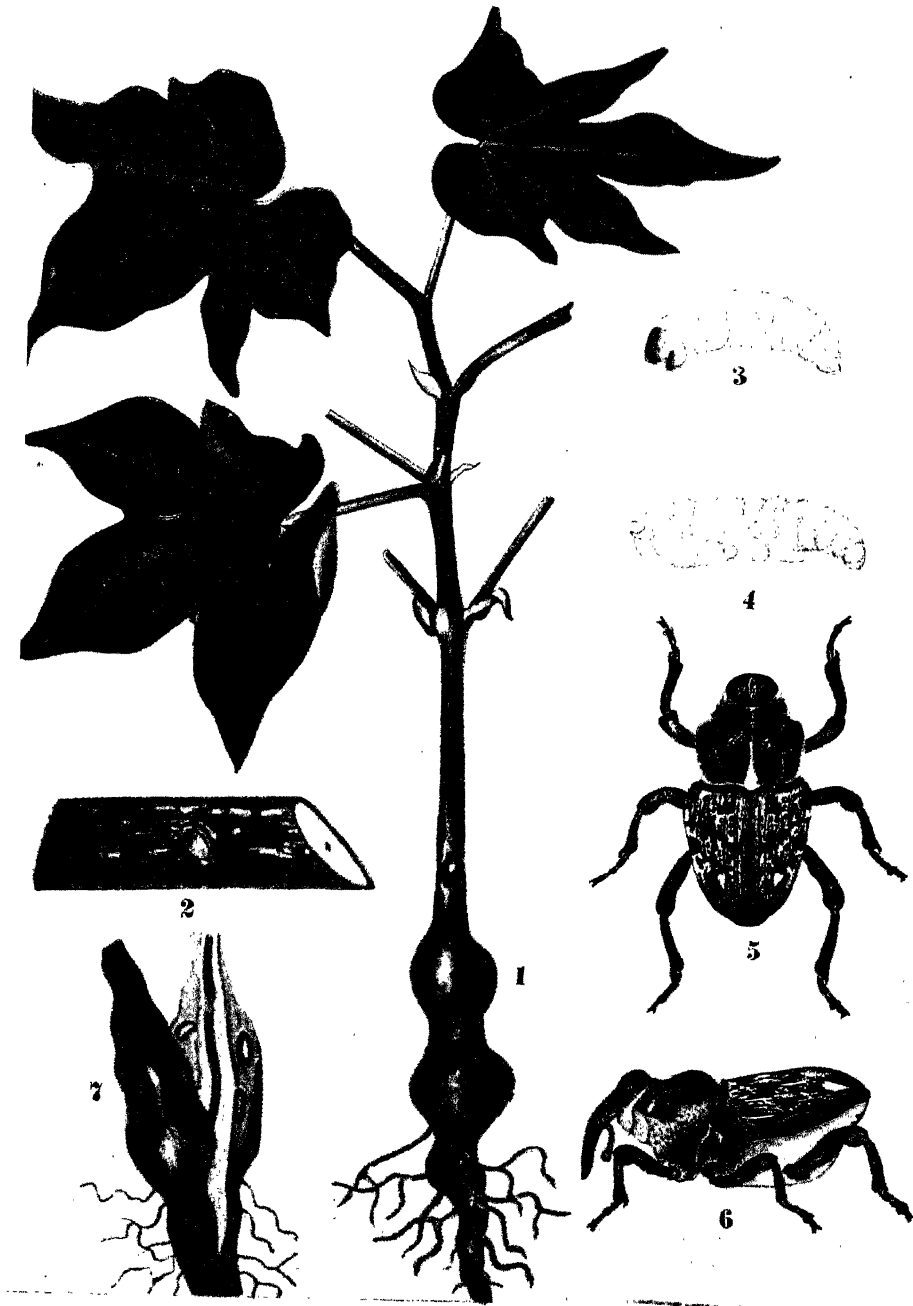


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8

Cotton Leaf-roller
(*Sylepta derogata*)



Cotton Stem-borer Weevil
(*Pempheris affinis*)

THE COTTON LEAF ROLLER.**(*Sylepta derogata* Fb.)**VERNACULAR AND LOCAL NAME—*Ywet-leik-pho*.**Plate 44.**

This caterpillar has the peculiar habit of cutting across a portion of the base of leaves and rolling them up, binding the roll with silk exuded from the mouth. Fig. 2 shows a grown up caterpillar on a rolled leaf but the caterpillar always lives hiding inside the roll and eating the leaf from inside. When fullgrown it transforms into a pupa (Fig. 4) also inside the roll and then issues as a moth (Figs. 6 and 8 in sitting and flying postures respectively). The moth is seen flying about in fields and depositing small scale-like eggs on leaves (Fig. 1) which however are not easily visible. The pest is most active about July to August and especially on broad-leaved cottons like Cambodia. The winter, as well as the hot weather, are passed by the caterpillars in rest under the soil. The majority of the resting caterpillars attain the adult state in June--July. Fig. 7 shows a hibernating caterpillar. Only fullgrown caterpillars can rest. In the active season the life-cycle takes about 25 to 30 days, *viz.*, egg 3 days, larva 15 to 20 days and pupa 7 days. Each female moth lays about 300 eggs.

A few to many young caterpillars are usually found in a single roll. The rolled leaves, especially the first ones, should be plucked off and burnt as soon as noticed. If this is systematically carried out at the commencement of the attack not much damage is done. The grown up caterpillars are rather sensitive and when disturbed usually spring out of the roll, but they should be destroyed. It is necessary to destroy all caterpillars. If this is done well there will be few moths the following year.

THE COTTON STEM BORER WEEVIL.**(*Pempheres affinis* Fst.)****Plate 45.**

The grubs (Figs. 3 and 7) of this weevil (Figs. 5 and 6) bore in the stem forming hypergrowths in the form of swellings or galls at the places bored (Fig. 1). Usually several grubs are present inside the galls. When fullgrown the grubs pupate (Fig. 4) inside their tunnels and ultimately issue as adult weevils which gnaw holes in the stem and deposit eggs in these holes (Fig. 2).

The weevil has been observed to occur only recently within the last five years on a cross of Cambodia and an U.S.S.R. cotton at Mahlaing. It is a bad pest of Cambodia in south India. It has been found to be able to breed on *Wagyi* and *Wagale*. The infected plants may break at the galls when swayed by high winds.

The infected plants should be uprooted and burnt in order that the pest may not increase. This method should be carried out carefully and systematically whenever the pest is met with.

N.B.—Another borer of cotton stems, a beetle belonging to the family Buprestidae is known in India but has not been met with in Burma.

THE SPINY BROWN COCCID.

(*Cerococcus hibisci* Gr.)

Plate 11, Fig. 3.

This light brown spiny-looking insect covers the stems and branches and its secretion falling on leaves and branches below develops a sooty fungus which gives the plants a black scorched appearance. Also the loss of sap sucked by so many insects stops further growth of the infested plant which soon dies. The indigenous *wagyi* and *wagale* types of cotton although fairly resistant to other pests suffer from this insect badly when it occurs and no steps are taken for control. When one plant is affected in a field many other plants in its neighbourhood all round are observed to be infected and to suffer.

This insect also occurs largely on the wild *paukhwe* (*Abutilon indicum*), garden hibiscus, holly-hock, shoe-flower, roselle, *Hibiscus cannabinus* (*chinboug*) and in fact may occur on all Malvaceous plants.

The infected plants should be uprooted and burnt. Spraying with rosin compound solution, if it can be carried out effects complete control.

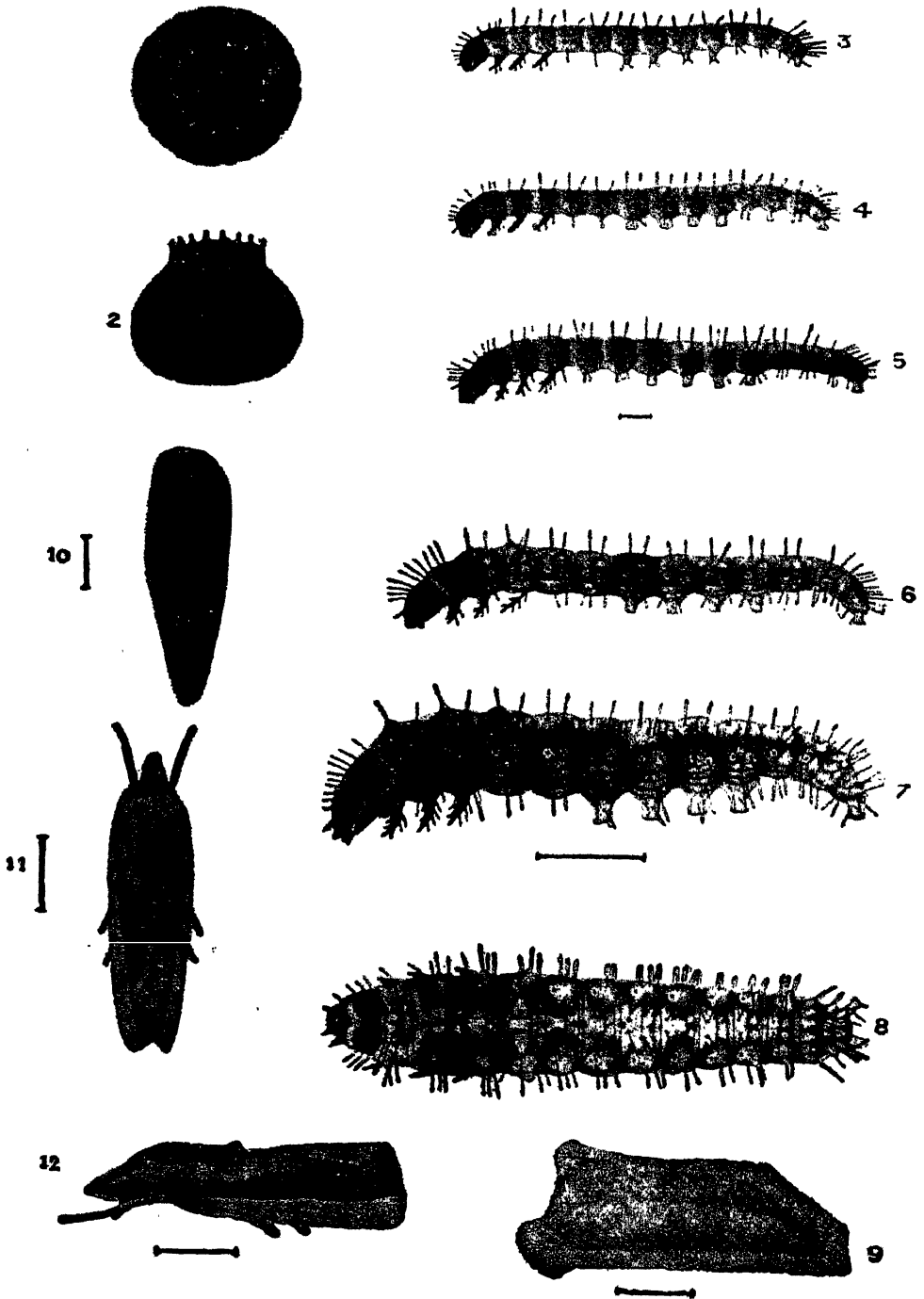
COTTON SHOOT BORER WEEVIL.

(*Alcides leopardus* Oliv.)

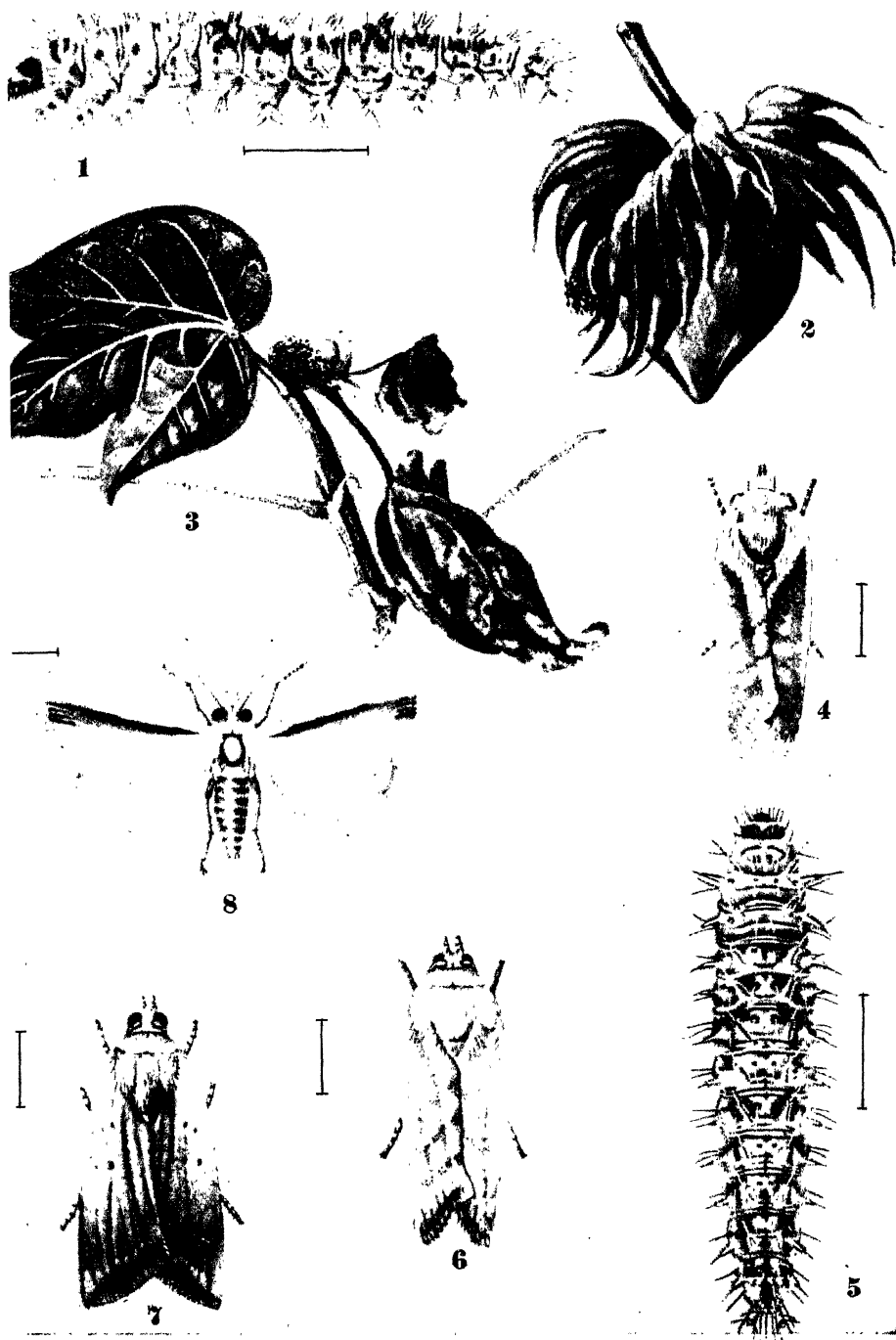
The grub of this weevil with similar life-history as the mango shoot borer (Text Fig. 79) is known to occur in small numbers boring top shoots and causing the bored shoots to wither. The grub pupates in the tunnel and ultimately develops into the adult weevil which is rather sluggish in habits. It is not likely to develop into a serious pest. Nevertheless it is advisable to cut off the withering shoots and burn them in order not to let the insect have a chance to increase in number.



Plate 46.



SPOTTED BOLLWORM (*Earias fabia*).



Spotted Boll-worm
(*Earias insulana*)

THE SPOTTED BOLL-WORMS.

(Earias fabia Stoll. and *Earias insulana* Boisid.)

VERNACULAR AND LOCAL NAMES.—*Wa-thee-~~po~~* ; *Wathee-sa-~~po~~* ; *Wathee-sok-~~po~~*.

Plates 46 and 47.

The caterpillars of the first-named are grey-brown with orange and white spots (Plate 46, Figs. 3 to 8) and those of the second have fleshy spines (Plate 47, Figs. 1 and 5). The habits of both are practically the same. The first occurs in much larger numbers than the second and is the real pest. These caterpillars bore the shoots of cottons like Cambodia but not *wagyi* and *wagale*, when the plants are young and no flower buds or bolls are present (Plate 47, Fig. 3). The bored shoots wither and droop. Growth ceases at the bored top and branches appear, the plants thus becoming bushy. The caterpillars then bore buds and subsequently bolls. The infested buds drop off. The buds and bolls which are attacked show holes and a quantity of frass is usually thrown out of these holes (Plate 47, Fig. 2). When the caterpillars are fullgrown they spin an elongated brownish or whitish cocoon (Plate 46, Fig. 9) on the stem, boll or leaf and transform into pupae (Plate 46, Fig. 10) inside this cocoon and after about ten days more issue out as moths with the forewings either wholly green or greenish yellow (Plate 47, Fig. 6) or with a broad green stripe along the middle (Plate 46, Figs. 11 to 12 and Plate 47, Fig. 8). These moths lay minute green eggs (Plate 46, Figs. 1 to 2 very much enlarged) on the plants from which the boll-worms hatch in about four or five days and feed by boring as described above for about two weeks before becoming fullgrown and spinning cocoons. In this manner fresh cycles occur in about a month.

These caterpillars also attack and bore the buds and pods of lady's finger, *Yon-ba-di-bin* (*Hibiscus esculentus*), fruits of *pauk-kwe-bin* (*Abutilon indicum*) and buds of *Kaung-yan-bin*, garden hibiscus and other plants. Breeding goes on throughout the year, but on a small scale when there is no cotton. Cotton affords abundant food and the pest has the chance of breeding on a large scale and thus multiplying in number. It continues to feed and breed on cotton as long as green buds and bolls are present.

The boll-worms bore through the locks inside the bolls in order to get at the seeds, the contents of which they eat. If all the locks are bored the bolls may split but never open. All the locks may not be affected in all cases but the locks which are affected do not open. Such unopened bolls and locks are usually rejected as useless and are not picked.

THE PINK BOLL-WORM.**(*Pectinophora gossypiella* Saund.)**

VERNACULAR AND LOCAL NAME.—*Pan-yaung-pho*, i.e., pink coloured insect (MINBU).

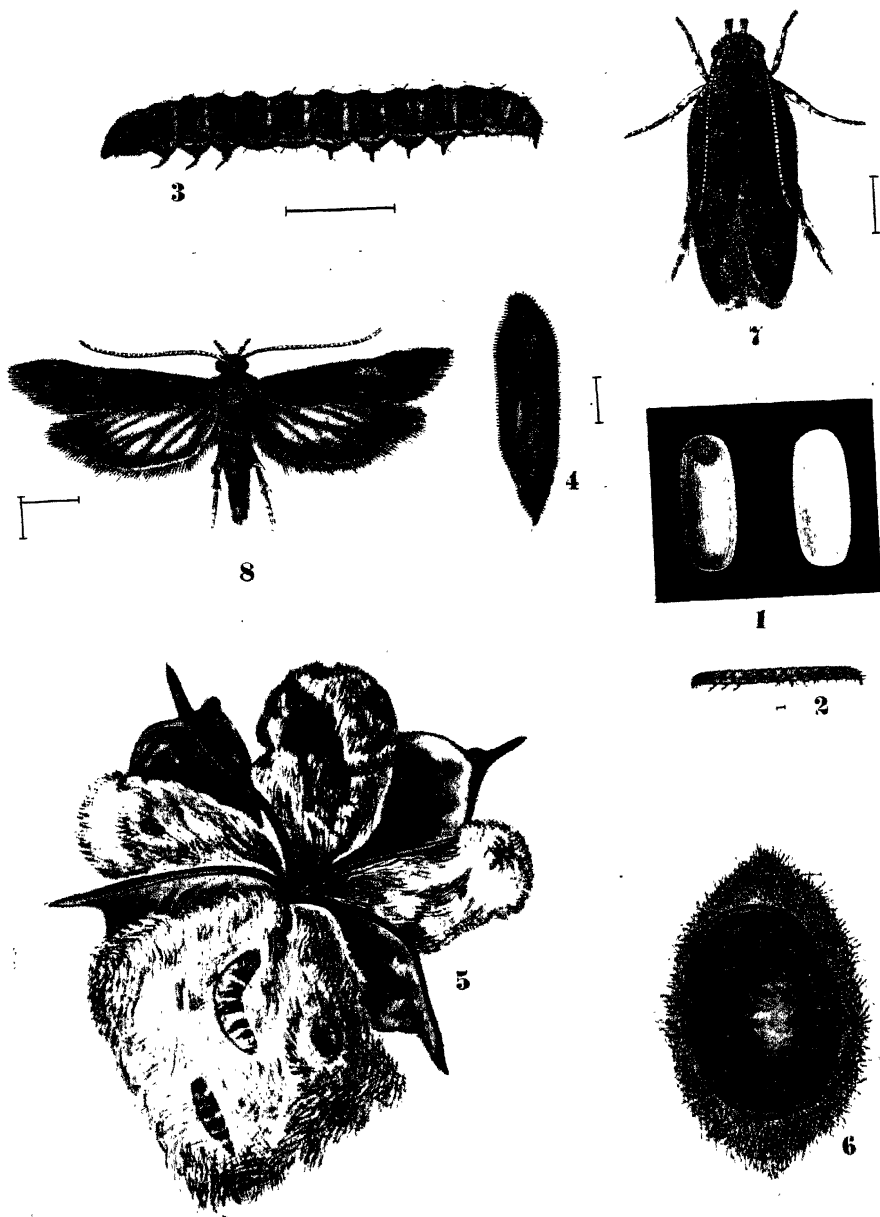
Plate 48.

This boll-worm (Figs. 2 and 3) is pink in colour. It may occur in very small numbers in buds but does so in very large numbers in bolls. The infested bolls hardly show any external symptoms while the caterpillars are boring inside. These caterpillars (Fig. 2) hatch from eggs (Fig. 1) laid by a small dusky-coloured moth (Figs. 8 and 7) and as they enter the bolls while young the entrance holes close up. They feed for about three weeks and then transform into pupae (Fig. 4) and issue as moths after about a week more. Fresh generations occur after intervals of about four to five weeks. At the end of the season, however, most of the caterpillars rest and do not transform and issue as moths before about two to six months and sometimes more. In some places they have been observed to rest in this manner for about two years. This period of rest is passed in various situations such as in the earth, among and inside seeds (Fig. 6) frequently two seeds being joined together for this purpose. At the end of the season each boll may harbour one to several of these caterpillars.

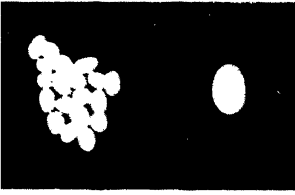
The Pink Boll-worms continue to live and rest in the unopened rejected bolls although they may be thoroughly dry. When however such bolls drop on the ground the caterpillars leave them and enter the earth and rest there.

Boll-worms, both Spotted and Pink, occur as pests of cotton in all countries wherever cotton is grown. Various attempts have been made to check them and it is possible to prevent their increase and thus minimise damage if all co-operate in carrying out the following measures :—

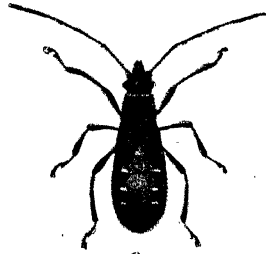
1. Sow cotton as early as possible so that an early harvest may be obtained. The boll-worms multiply to a great extent towards the latter part of the season.
2. Cut off all withering tops as soon as noticed and burn them.
3. Pick off all green bolls from which frass is being thrown out and burn them.
4. While picking cotton pick off the unopened bolls and locks which are rejected as not worth picking and burn them.
5. As soon as it is decided not to take any more pickings from the cotton cut off or uproot all the plants and burn them. The purpose is also served if all the bolls remaining on the plants are picked off and burnt.



Pink Bollworm
(*Pectinophora gossypiella*)



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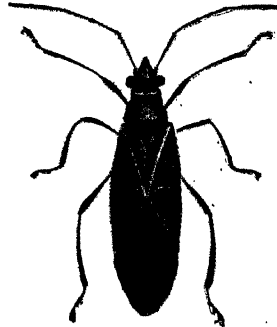
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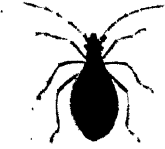
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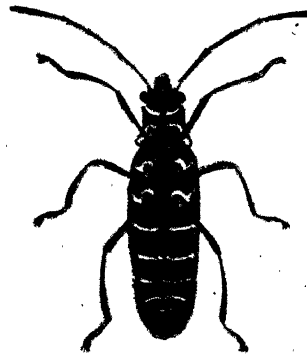
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5



8



Red Cotton Bug
(Disdercus Cingulatus)

The fallen buds, flowers and bolls should be picked up once every seven days and burnt as they harbour many caterpillars.

THE RED COTTON BUG.

(*Dysdercus cingulatus* Fb.)

VERNACULAR AND LOCAL NAMES.—*Po-ni-gaung*, *Wa-gun-po-ni-gaung*.

Plate 49.

Among several insects which attack the cotton plant this is perhaps the best known on account of the vivid red colour and peculiar markings. It pierces the stems, leaves, flowers and bolls of cotton and other plants of the same class such as lady's finger, roselle, hollyhock, etc., with its long slender beak, which lies between its legs when not in use and sucks juice.

The female lays, under the surface of the earth, from fifty to sixty oval eggs, which are of a light yellow colour (Fig. 1). Within a week, tiny red insects emerge from the eggs and attack the food plant in their vicinity. They resemble their full-grown parents, but are smaller in size and have no wings. They grow and cast off their skin five times before they attain the adult state with fully developed wings in the course of about 40 days. Figs. 2 to 7 show the various stages of growth.

Great damage is caused to cotton bolls which are pierced with the needle-like beak which is pushed in until the seeds inside are reached. The seeds thus sucked become useless either for sowing or expression of oil. Disease germs are also introduced into the bolls and an internal rot of bolls frequently occurs principally owing to attack by this insect. As the insect congregates on the ripe open bolls the cotton becomes stained by their excrement and deteriorates in quality and hence also in value. Crushed bugs also stain the lint. The adult bugs fly in and breed in the field. Very soon swarms of young ones appear and as all feed by sucking the plants severe damage may take place.

The simplest and at the same time the most effective method of keeping the bug under control is to shake the insects off the plants into a tin containing a mixture of kerosene and water, or to trample them under foot when they fall on the ground. The field should be gone over at intervals of a few days so that the adult bugs which fly in are caught and no young bugs may be given birth to in the field.

Trap Crop for spotted Boll-worms and the Red Cotton Bug.

The pods of *Hibiscus abelmoschus* (*kon-kado*) grown by some people for seeds which are used for chewing with betel, are very much liked by the Red Cotton Bug and also the Spotted Boll-worm, *Earias fabia*. If a small plot of these plants can be grown so that they are in fruit when the cotton bears bolls many Red Cotton Bugs and Spotted Boll-worms can be kept off from cotton. Red Cotton Bugs from the neighbourhood fly to the *kon-kado* plot and should be collected by being shaken into a pot containing water and kerosene oil. Unless however the plants bear fruits no bugs are attracted. Green pods which show holes should be regularly picked off and burnt as they contain Spotted Boll-worms.

Unless one is prepared to undertake that *kon-kado* is in fruit by the time cotton flowers and to carry out the picking of Red Cotton Bugs and Spotted Boll-worms no *kon-kado* should be grown in the neighbourhood of cotton.

THE DUSKY COTTON BUG.

(*Oxycarenus latus* Kby.)

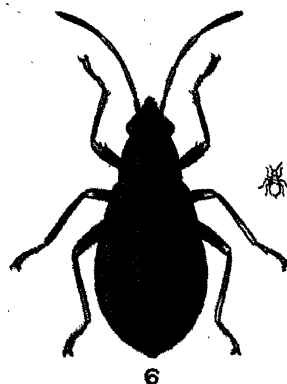
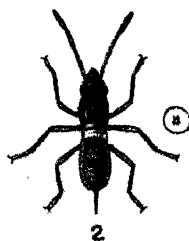
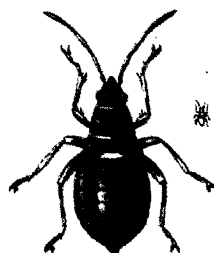
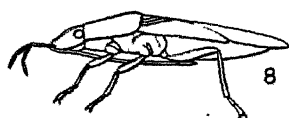
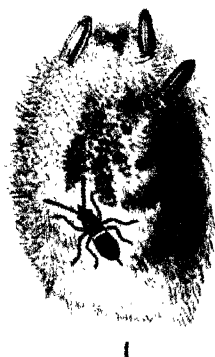
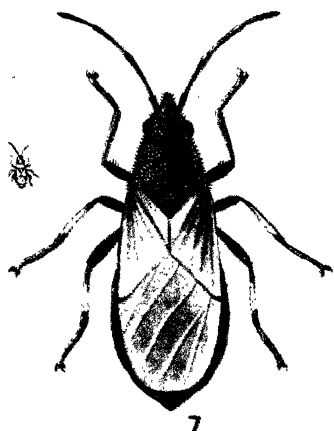
Plate 50.

This small bug occurs in large numbers on open or on partly open mature and dry bolls (Fig. 9). The adult bug (Fig. 7) has wings but makes little use of them and generally walks about. Eggs are deposited among the lint (Fig. 1) and the young nymphs also feed like the adult by sucking the juice from seeds and gradually grow, casting off skins at intervals and developing wing pads with growth, as will appear from the figures 1 to 6 in the plate. With the development of full wings the bug attains the adult state (Fig. 7), Fig. 8 showing it in outline from the side. Eggs hatch in about 5 days and the nymphs attain the adult state in about 30 days.

The bug also occurs, though in small numbers, on flowers and green bolls. It does not appear to cause appreciable damage by actual feeding but probably transmits and spreads disease in the same way as the larger Red Cotton Bug is definitely known to do.

The bugs can be easily shaken off into pots like the Red Cotton Bugs.

If the partly open or unopened rejected bolls are picked off and destroyed the majority of these insects will be destroyed along with them.



Dusky Cotton Bug
(*Oxycarenus laetus*)

THE WHITE MEALY BUG ON COTTON SHOOT.

(Pseudococcus sp.)

Text Fig 50.

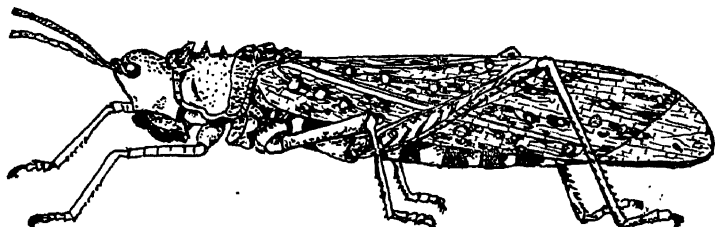
WHITE MEALY BUGS ON COTTON.

This mealy bug occurs chiefly at the tops of the plants causing them to crumple up and cease growth. As the young ones spread by crawling and are also blown by wind, when one plant is affected there is a chance of the neighbouring ones being affected.

The affected tops as soon as noticed should be nipped off and burnt. Spraying with rosin compound solution if it can be carried out effects perfect control.

THE SPOTTED GRASSHOPPER.

(*Aularches miliaris* |Lin.)



Text Fig. 51.

THE SPOTTED GRASSHOPPER (*Aularches miliaris*) (NATURAL SIZE).

On account of its large size and prominent colour this grasshopper attracts attention wherever it occurs. It has the habit of sitting in company, apparently being attracted together for breeding purposes. Among plants of economic importance it has been observed to occur on cotton, sesamum, pigeon pea, castor, coconut and beans. It has also been reported on custard apple, *Cordia myxa*, *Cassia*, *Acacia leucophlœa*, *Melia azadirachta*, *Striga lutea* and *Baliospermum axillare*. In India it is known to occur on coffee, coconut and *Erythrina*.

In only one year 1911 it was reported that it had appeared on about 250 acres of cotton in Meiktila District. Since then no occurrence of any importance has been noticed.

As the insect eats leaves a number occurring on a plant may cause some damage. As a rule it is not a pest of much importance.

Whenever it occurs it can be easily caught and destroyed with hand nets.

On lady's finger (*Yonbadi*, *Hibiscus esculentus*).

The same insects which occur on cotton may occur on this crop.

On Roselle and Holly hock.

The Cotton Leaf Roller, the Red Cotton Bug and the Spiny Brown Coccid occur on them.

On shoe-flower (*Hibiscus rosa-sinensis*).

Aphis and the Spiny Brown Coccid occur on it. Control measures are given under general pests.

Occasionally Blister beetles (Text Fig. 52) eat flowers and require to be collected with hand nets.



Text Fig. 52.

BANDED BLISTER BEETLE (NATURAL SIZE).

On chinboun (*Hibiscus cannabinus*).

This crop is grown in fields and gardens mainly as a vegetable for the leaves but not on a large scale. Its leaves are in some years eaten by the Sesamum Black Beetle (Text Fig. 53). The Spiny Brown Coccid occurs on the stem. Some of the other cotton pests may also occur on it. The Cotton Leaf Rollers may affect the leaves and the Red Cotton Bugs the fruits.

PESTS ON OIL SEED CROPS.

On Sesamum.

THE COMMON HAIRY CATERPILLAR.

(*Diacrisia obliqua* Wlk.)

Plate 32.

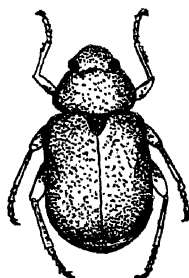
This is occasionally serious on sesamum occurring over wide areas and causing widespread damage, the plants being stripped of leaves.

As will appear from the detailed life-history given at page 94 it is easily possible for the cultivators to prevent the pest from increasing in number by the collection of eggmasses and gregarious young caterpillars. As a matter of fact if all cultivators co-operate no damage need be suffered at all. The pest may appear in injurious numbers on *pegyi* and its varieties and on sesamum, both early and late. All these crops require to be watched.

THE SESAMUM BLACK BEETLE.

(Anomala antiqua Gyll.)

VERNACULAR AND LOCAL NAMES.—*Gyaing-gaung* (Magwe); *Kyaing-gaung* (Minbu).

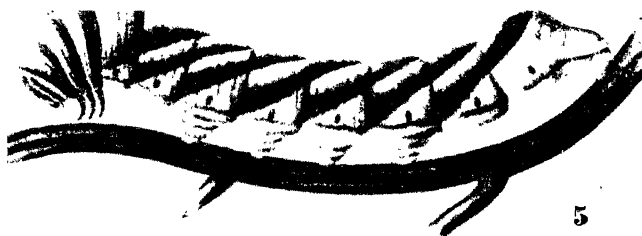


Text Fig. 53.

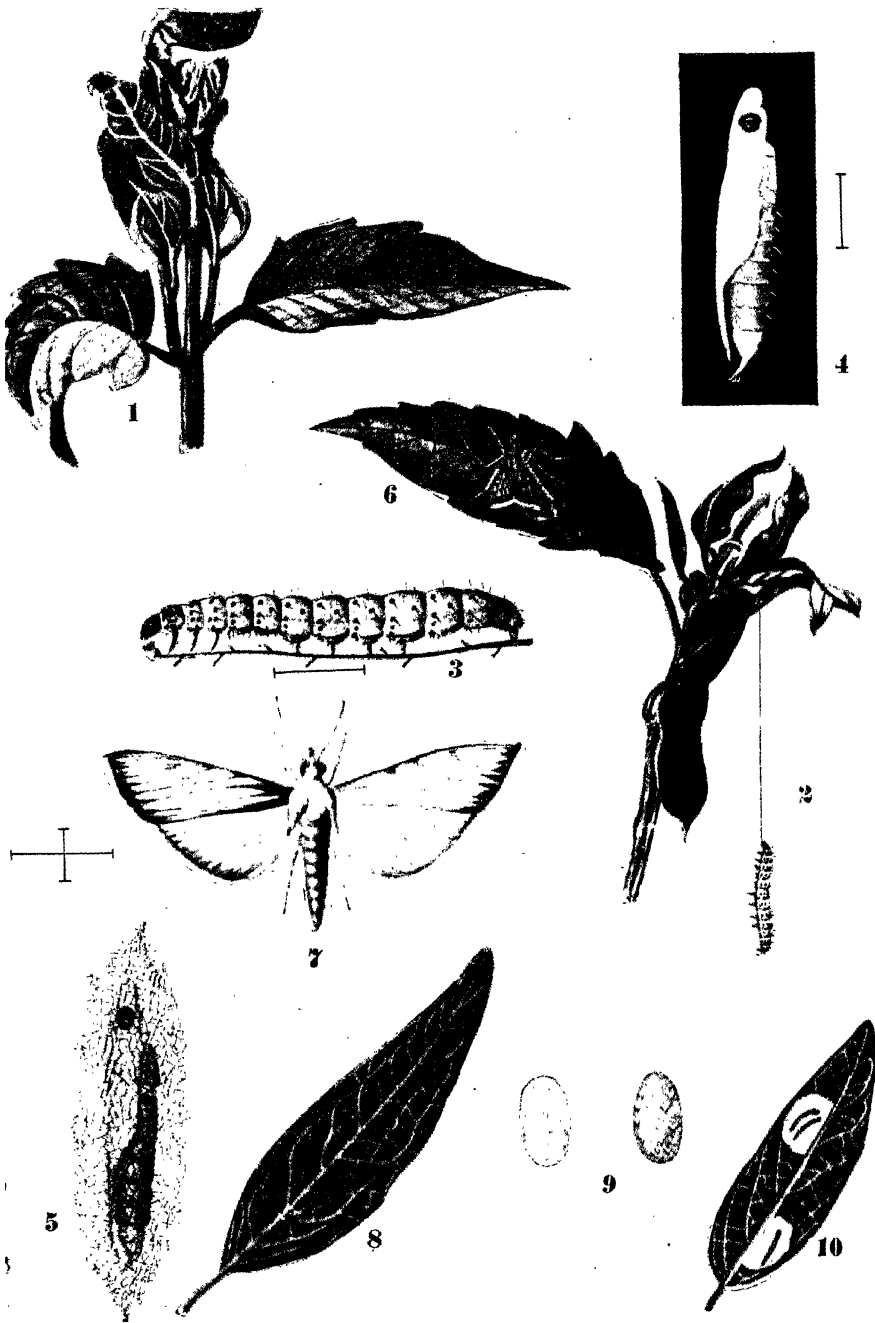
SESAMUM BLACK BEETLE (*Anomala antiqua*).

This beetle and its grubs (chafer grubs) like those shown in Plate 7 are pests causing damage to several crops in Upper Burma. The beetles appear in swarms after the first showers of rain and congregate on early sesamum in the evenings and eat off the leaves. They also eat *chinboun* (*Hibiscus cannabinus*) leaves in the same way. They lay eggs in the soil and the chafer grubs eat mostly humus in the soil, dung, rotten leaves and vegetable matter as well as roots of grasses and groundnut. The groundnut crops in Myingyan, Magwe and other districts suffer severely in some years from these grubs and the affected plants die. After feeding till about September the grubs go down deeper into the soil, prepare pupal cells and rest in these cells till about March when they transform into pupæ, attaining the adult state soon after. The adult beetles issue in swarms after the first heavy showers of rain as described above. The beetles are found flying after dusk with a humming noise round *kokobin* trees (*Pithecolobium saman*) in the early rains and apparently eat the flowers.

The beetles and their grubs occur in large numbers and behave as pests only occasionally and on a few crops. The beetles require to be collected on sesamum and *chinboun* in the evenings, being shaken off into vessels containing water and a fair amount of kerosene oil, or they can be crushed. If the plants are sprayed with kerosene emulsion the smell of the kerosene keeps off the beetles for two or three days.



The Sesamum Sphingid
(*Acherontia styx*)



Sesamum Leaf-roller
(*Antigastra catalaunalis*)

THE SESAMUM SPHINGID**(or Death's Head Moth Caterpillar).****(*Acherontia styx* Westw.)****Plate 51.**

This large caterpillar (Figs. 2 to 5) with a horn at the tail occasionally occurs in numbers on sesamum devouring the leaves. When fullgrown it goes down into the soil, forms a pupal cell and transforms into a pupa (Fig. 6) in this cell. The moth (Fig. 7) develops from the pupa and is called the Death's Head Moth on account of some markings on its neck. The moths fly at night and deposit round pearly eggs (Fig. 1) on leaves and shoots. The caterpillars hatch from these eggs in about 3 to 4 days, feed for about 21 days and remain as pupæ for about 15 days. Usually hibernation and aestivation take place in the pupal state from about November to May.

The caterpillars and even eggs are easily visible and require to be picked off and destroyed.

THE SESAMUM LEAF ROLLER.**(*Antigastra catalaunalis* Dup.)****Plate 52.**

This spotted green caterpillar (Figs. 2 and 3) at first appears as a top leaf roller webbing up the top leaves and feeding from inside (Figs. 1 and 2). Usually several caterpillars occur together. When flowers and fruits appear on the plants, the flowers are similarly webbed up and damaged and the fruits are bored, the seeds being eaten. When full-grown the caterpillars transform into pupæ inside silken cocoons formed in the webbing (Figs. 4 and 5) and ultimately develop into moths (Fig. 6 in sitting and Fig. 7 in flying postures). The caterpillars hatch from the eggs (Figs. 8 and 9) laid by the moths. Young caterpillars mine leaves (Fig. 10). The life-cycle ordinarily takes about four weeks, *viz.*, egg about 4 days, larva about 15 to 20 days and pupa 5 to 6 days. The periods are lengthened if it is cold. Each moth lays about 200 eggs.

It is necessary to keep watch and pick off and either bury or burn the webbings as they appear. If this is carried out systematically the pest gets no chance to increase and cause damage.

THE SESAMUM SEED BUG.

(Aphanus sordidus Fb.)

Text Fig. 54.

SESAMUM SEED BUG (*Aphanus sordidus*).

This bug has a life-history similar to that of several bugs described in this book, for instance the Green Bug, page 104, the Painted Bug, page 128, and others. Nymphs hatch from eggs laid by the adult bugs and feed in company of, and in the same way as, adults by sucking sesamum seeds and grow ultimately developing into adults themselves. The bugs appear in large numbers and continue to do damage in the threshing yards.

Hardly anything can be done against them in the fields, but in the threshing yard, when the sesamum heaps are shaken, the bugs leave the heaps and walk or rather run all round and should be swept up and placed in kerosenised water or buried under ground.

This bug sometimes occurs on groundnuts and sesamum seeds in store and should be disposed of in the same manner.

ON GROUNDNUT.

Cock-Chafer grubs.

(Anomala antiqua Gyll.)

Text Fig. 53.

Grubs of the Sesamum Black Beetle sometimes occur in groundnut fields, especially in sandy places, and cut the roots of the plants which wilt as a consequence. The grubs of course hatch from eggs laid by the beetles in the fields.

As a single grub cuts several plants it is necessary to collect the grubs by raking up the soil.

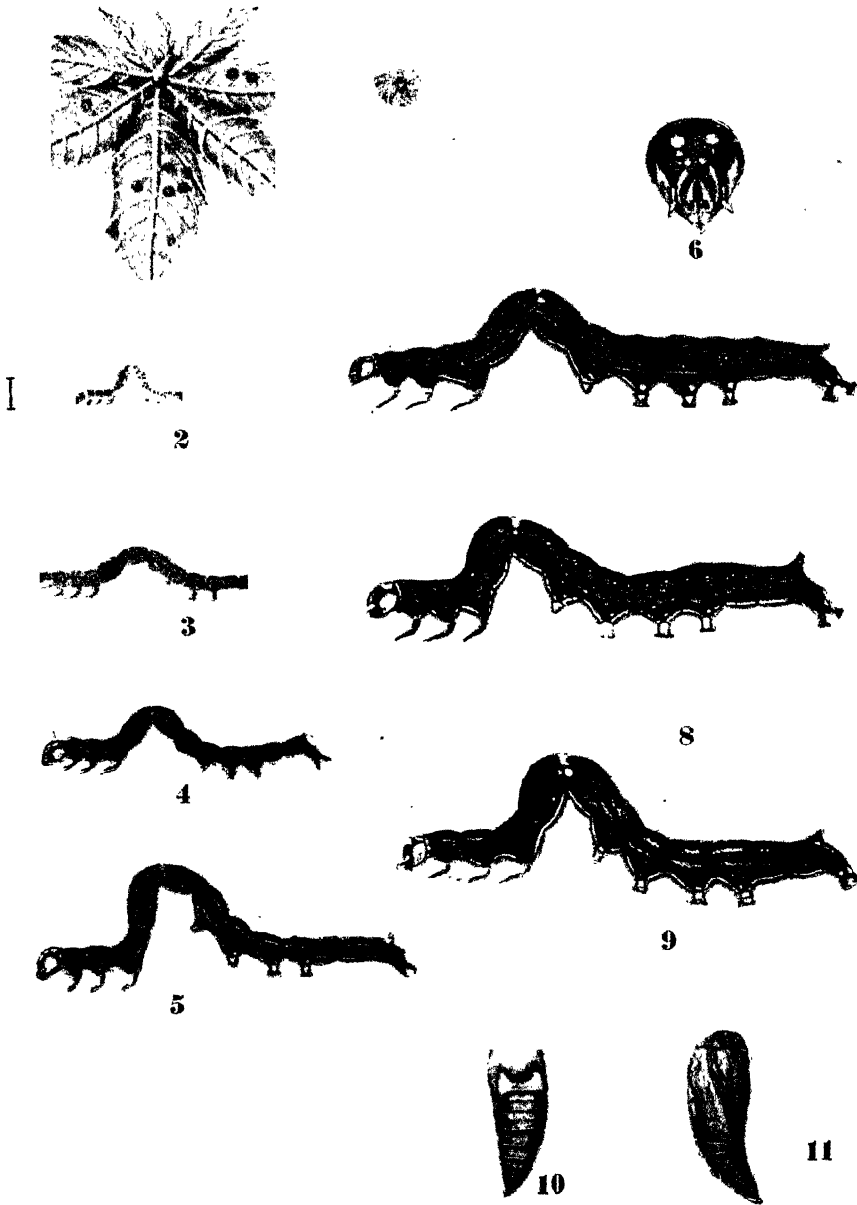
TERMITES (WHITE ANTS).

Plate 5.

Termites occasionally cut plants but hardly ever on any large scale.



Castor Semilooper
(*Achæa janata*)



Castor Semilooper
(*Achæa janata*)

JASSIDS.**Plate 22 and Text Fig. 75.**

In unfavourable seasons jassid bugs may occur on the leaves causing them to curve somewhat and look somewhat scorched. The plants however recover under improved conditions.

THE SESAMUM SEED BUG.**Text Fig. 54.**

This bug as already indicated sometimes occur on the nuts in store.

ON CASTOR.

Of the general pests mites and a yellow mealy-wing (Plate 13) occur on the leaves as pests. A jassid bug (*Empoasca flavescens*) may also occur.

The Tobacco Caterpillar (Text Fig. 59) and the Common Hairy Caterpillar (Plate 32) occasionally occur as pests.

Besides the above castor has several specific pests described and illustrated below.

THE CASTOR SEMILOOPER.

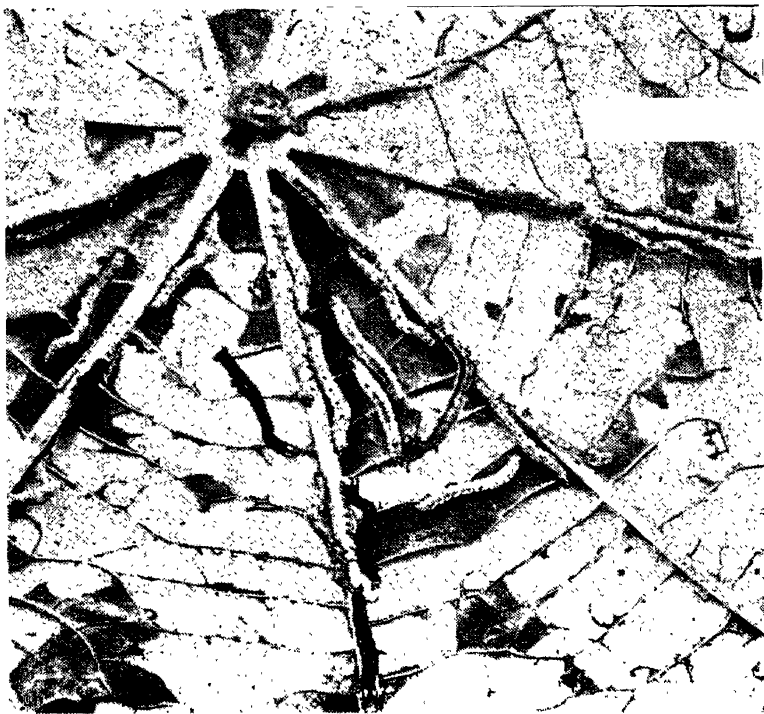
(*Achæa janata* Linn.)

Plates 53 and 54.

This semilooper (Plate 54, Figs. 2 to 9) is the worst pest on castor, sometimes occurring in enormous numbers and defoliating the plants over whole fields (Text Fig. 55). When fullgrown they form cocoons (Plate 53, Figs. 1 and 2) either in folds of leaf on the plant or among debris on the ground and transform into pupæ (Plate 54, Figs. 10-11) inside the cocoons and ultimately emerge as moths (Plate 53, Fig. 3 in sitting and Figs. 4 and 5 in flying postures). The moths lay eggs (Plate 54, Fig. 1) on the leaves and these miloopers hatch from these eggs. The life-cycle takes about three weeks, *viz.*, egg 2 days, larva 10 to 12 days and pupa 10 days. Each female moth lays about 400 to 500 eggs. The insect hibernates in cold weather as a pupa.

Plate 53, Fig. 7 shows a small wasp which is parasitic on the semilooper. The parasitised semilooper hangs with its head down by grasping a twig as shown in Plate 53, Fig. 6 which has however been

drawn in horizontal position.



Text Fig. 55.

CASTOR SEMI-LOOPERS FEEDING.

The semiloopers do not occur in large hordes all at once but are bred on the plants themselves. If a watch is kept and the first semi-loopers which occur are picked off the pest gets no chance to increase to injurious numbers.

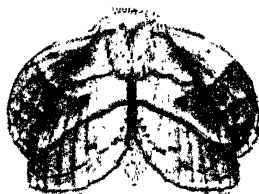
CASTOR HAIRY CATERPILLAR;

Besides the Common Hairy Caterpillars (Plate 32) castor may be attacked by three other hairy caterpillars one of which is described below.

(Trabala vishnu Lef.)

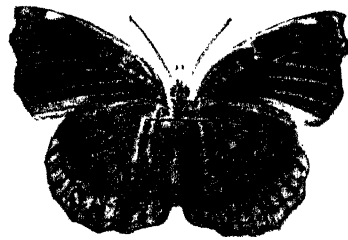
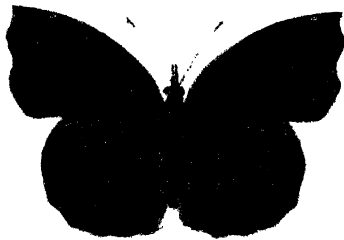
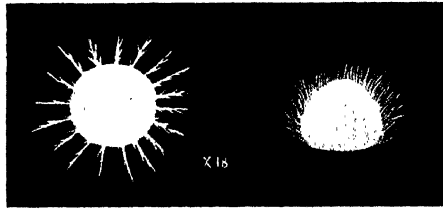
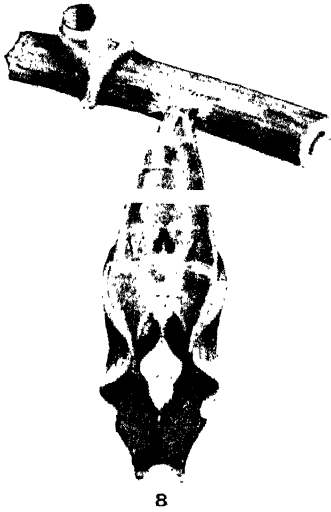
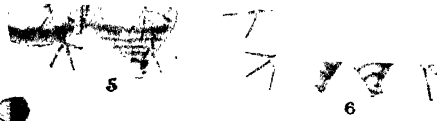
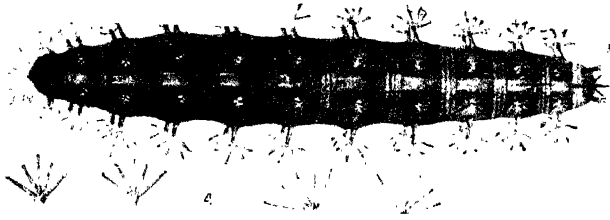
Plate 55.

This hairy caterpillar (Figs. 2 to 4) hatches from slatecoloured round eggs deposited in double rows covered with hairs (Fig. 1). The egg cluster looks like a hairy caterpillar. The caterpillars eat leaves and when fullgrown form bag-like cocoons (Fig. 5) on leaves or stems by weaving the hairs on their body with silk and transform into pupæ (Figs. 6 to 7) in these cocoons. Moths (Fig. 8 female and Fig. 9 male) develop from the pupæ and issue out of the cocoons through one end,



8





Castor Spiny Caterpillar
(*Ergolis merione*)

mate and lay eggs. In hot weather the life-cycle is completed in about 42 days, *viz.*, egg 7 days, larva about 24 days and pupa 11 to 12 days. In cold weather it may take four times as long, all the stages being lengthened.

THE CASTOR SPINY CATERPILLAR.

(*Ergolis merione* Cram.)

Plate 56.

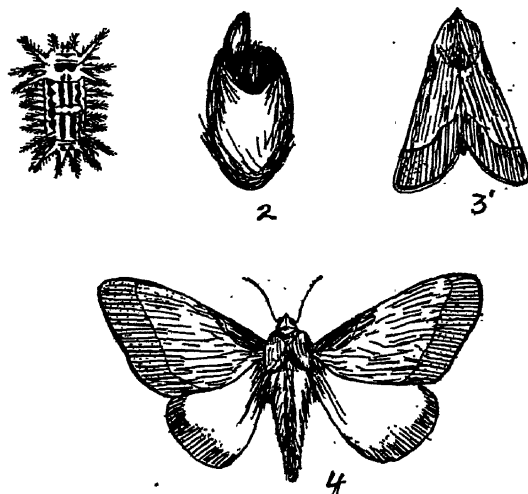
A caterpillar armed with spines on its body eats leaves (Figs. 3 and 4. Figs. 5 and 6 show arrangement of the spines on the body and Fig. 7 a single spine). When fullgrown it attaches its hind legs with silk to a leaf or stem and hangs head downwards, transforming into a chrysalis (Fig. 8). The butterfly (Figs. 9 and 10 upper and under surfaces) emerges from the chrysalis and deposits white hairy eggs on the leaves (Fig. 1 viewed from above and Fig. 2 from a side). The caterpillars hatch from these eggs. The life-cycle ordinarily takes about three weeks, *viz.*, egg 3 days, larva 10 to 12 days and pupa 7 days. These periods are lengthened in the cold weather.

The caterpillars can be picked off and the butterflies observed flying about among castor during the day time can be caught in hand nets. The caterpillars however seldom increase to injurious numbers.

CASTOR NETTLE GRUB OR SLUG.

(*Parasa lepida* Cr.)

VERNACULAR AND LOCAL NAMES.—*Hkin-che-ron* (Bhamo—*Kachin*) ;
Tim-hi, i.e., fire insect (Leiktho—*Gebba-Karen*).



Text Fig. 56.

NETTLE GRUB ON CASTOR (*Parasa lepida*).

1. SLUG-LIKE CATERPILLAR, 2. COCOON, 3. MOTH SITTING, 4. MOTH FLYING.

A slug-like green caterpillar with urticating hairs which cause irritation if they touch the skin, eats leaves. When fullgrown it forms a hard globular cocoon on the leaf or stem and pupates inside, ultimately issuing as a moth out of the cocoon by opening a portion as a lid. The moth lays eggs from which the slugs are born. The life-cycle takes about five weeks. These caterpillars are also known to occur on rose, coconut, mango, plantain and other leaves but hardly ever in injurious numbers.

THE CASTOR FRUIT AND SHOOT BORER.

(*Dichocrocis punctiferalis* Guen.)

Plate 57.

This black-spotted caterpillar (Fig. 3) bores fruits and stems and webs up flowers on the shoots (Figs. 1, 2 and 3), living under webbings of frass. When fullgrown it forms a silken cocoon (Fig. 5) under frass or inside bored seeds (Fig. 4), transforms into a pupa and ultimately emerges as a moth (Fig. 6). The moth lays eggs from which the borer caterpillars are hatched. The life-cycle takes about five weeks. The moths sitting on the leaves are natural size. This caterpillar is also known to bore other fruits such as peach, guava, pomegranate, plums, etc.

If the webbings are scratched the caterpillars are injured and die. Attacked fruits emitting frass are better plucked off and the caterpillar destroyed.

CASTOR MEALY-WINGS.

(*Trialeurodes ricini* Misra.)

Plate 13.

This mealy-wing occasionally proves very serious, covering all leaves which as a consequence lose colour and in the worst cases may drop off.

A single spray with rosin compound solution is effective if spraying is possible. Removal and burning or burying of first affected leaves puts a check to its increase.

ON LINSEED.

Linseed is a newly introduced crop in Burma and has been observed to be liable to damage by the Linseed Caterpillar. The Tobacco Caterpillar (Text Fig. 59) and the Green Semilooper (Plate 34) also occur occasionally on it.

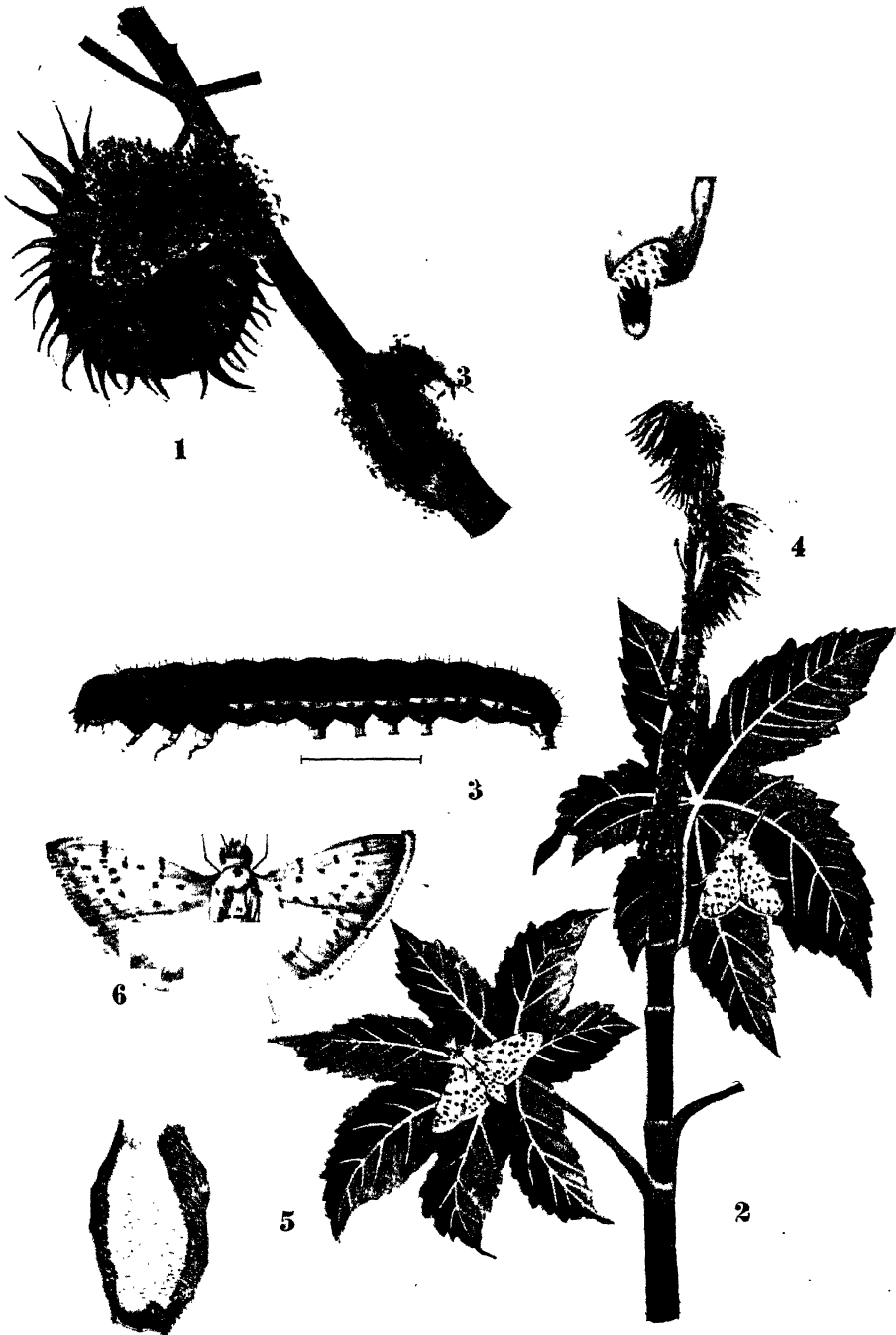
THE LINSEED CATERPILLAR.

(*Laphygma exigua* Hb.)

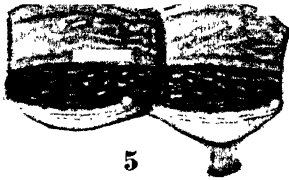
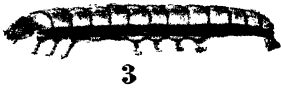
VERNACULAR AND LOCAL NAME.—*Amyit-pho* (Mandalay-Meiktila).

Plate 58.

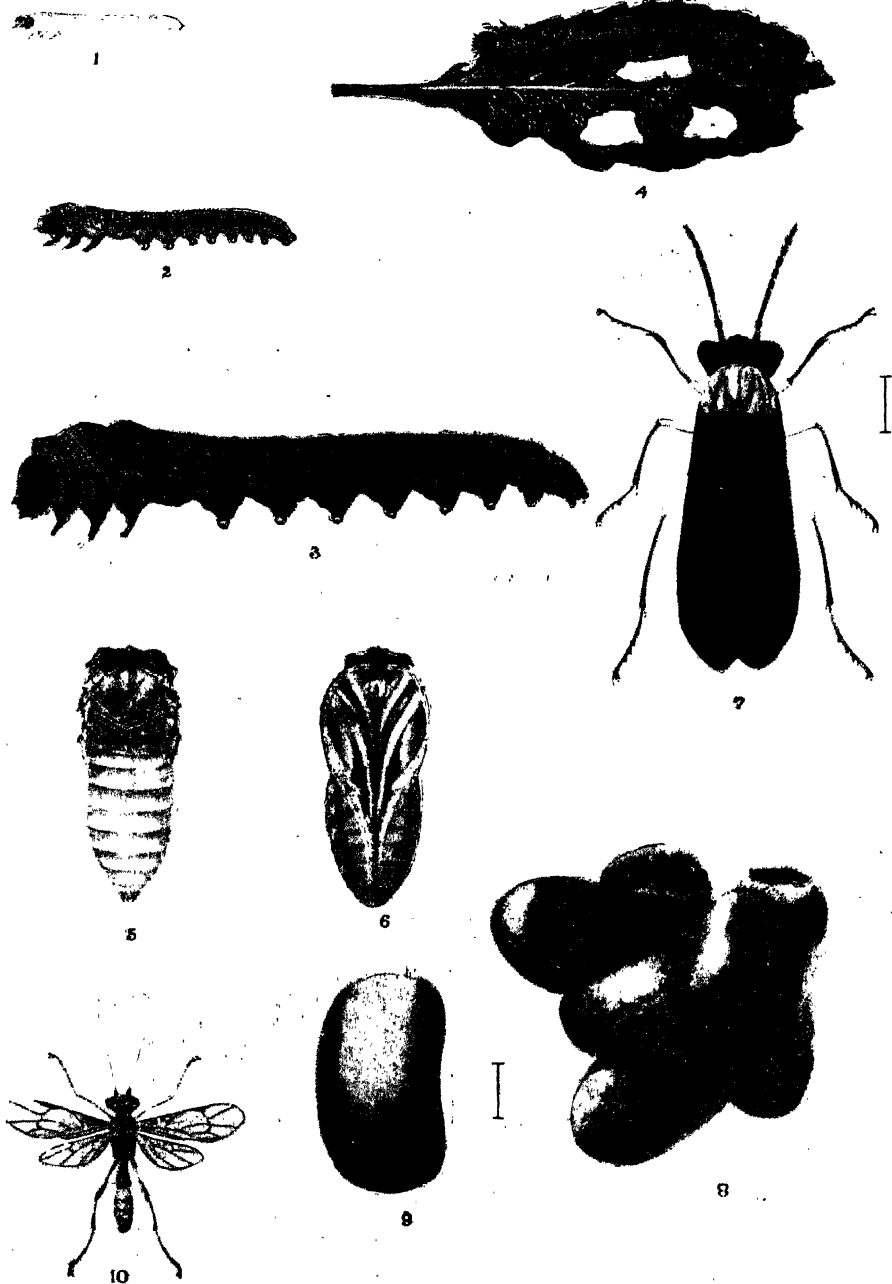
This caterpillar (Figs. 2—4, 7, 8) which varies in colour being green, pinkish-brown or blackish, occurs on linseed and behaves as a persistent



Castor Fruit and Shoot Borer
(*Dichocrocis punctiferalis*)



Linseed caterpillar (*Laphygma exigua*)



Mustard Saw-fly
(*Athalia proxima*)

pest on it. In the young stage the caterpillar is of leaf-rolling habit, webbing up leaves with silk and feeds from inside the webbing. Grown caterpillars may live on plants or underground. Damage is caused not only by leaves being eaten but also by the bark of roots being eaten all round causing the plant to wilt and dry. The caterpillars mostly live on the plants eating leaves. When fullgrown they go down into the soil and pupate there (Fig. 9) ultimately emerging as moths Figs. 10, 11. The life-cycle ordinarily takes about four weeks, *viz.*, egg 5 to 6 days, larva about 20 days and pupa about 6 days.

The only method which can be suggested is to sweep the plants with hand nets. The caterpillars are caught up in the nets and can be destroyed.

PESTS ON CRUCIFEROUS CROPS.

On Mustard.

Mustard is usually grown in Burma as a vegetable and not as an oil seed crop.

Of the general pests aphid is frequently bad on it.

The following pests are also known to attack this crop.

THE MUSTARD SAW-FLY.

(*Athalia proxima* Klug.)

Plate 59 and Plate 62 (Figs. 12-13.)

Sooty-black caterpillar-like grubs (Figs. 1 to 4) are found eating the leaves and in some years occur in such large numbers especially on young plants that the crop may be spoilt. Young cabbage, cauliflower and other cruciferous plants are also attacked. When fullgrown the grubs go down into the soil and form elongate oval cocoons with silk and earth and transform into pupæ inside these cocoons (Fig. 8 a cluster of cocoons and Fig. 9 a single cocoon ; Fig. 5 pupa viewed from back and mature and Fig. 6 viewed from the front and fresh). The saw-fly (Fig. 7) develops from the pupa and issues out of the cocoon by biting a hole at one end (Fig. 8). The saw-fly slits open the edges of leaves with her ovipositor and inserts eggs into these slits. The eggs are therefore not seen. The destructive sooty-black grubs hatch from these eggs. The insect is active and breeds only in the cold weather. The rest of the year is passed in sleep in the cocoon. The life-cycle in the breeding season takes about four weeks, *viz.*, egg 4 days, grub 10 to 12 days and pupa about the same period.

Fig. 10 in the plate shows a wasp which deposits eggs in the body of the grubs and this wasp grub eats the contents of the body of the host which however is able to spin a cocoon before being killed. This little wasp is parasitic on the grubs.

The black grubs are easily seen and are best picked off regularly and destroyed. This is the simplest and most effective remedy though taking time. The grubs can also be killed by being sprayed with strong rosin compound solution. But spraying requires to be repeated as eggs which are not affected by the spray hatch later on. Seed beds of cabbage, cauliflower, etc., should be watched.

THE PAINTED BUG.

(*Bagrada picta* Fb.)

Plate 60.

This prominently coloured bug (Fig. 6) feeds by sucking the juice and also breeds on the plants. Small oval eggs (Fig. 1) are laid on the leaves. Young nymphs hatch from these eggs in about four days, feed in the same way as the adult bug and gradually grow, developing wing pads with growth (Figs. 3 to 5) and attaining the adult state in the course of three to four weeks when the wings are fully developed. The nymphs and adults live and feed somewhat gregariously and soon form large colonies. The infested plants are weakened through loss of sap. The adult bugs live for about one to two months. Each female lays about 200 eggs.

The bugs and nymphs can be shaken or picked off into vessels containing water and kerosene. Spraying with strong rosin compound solution rids the plants of them.

THE MUSTARD CATERPILLAR.

(*Crociodolomia binotalis* Zeller.)

Plate 61, Figs. 1 to 5.

This caterpillar (Fig. 2) webs up leaves and flowers and also bores pods. When fullgrown it forms a cocoon on the plant or on the ground with silk and debris (Fig. 3) and transforms into a pupa (Fig. 4) inside this cocoon whence it ultimately issues as a moth (Fig. 5). The moth lays eggs in clusters (Fig. 1) on leaves and from these eggs the caterpillars hatch. The life-cycle takes about four weeks, viz., egg 4 to 5 days, larva 15 to 20 days and pupa 6 to 8 days.

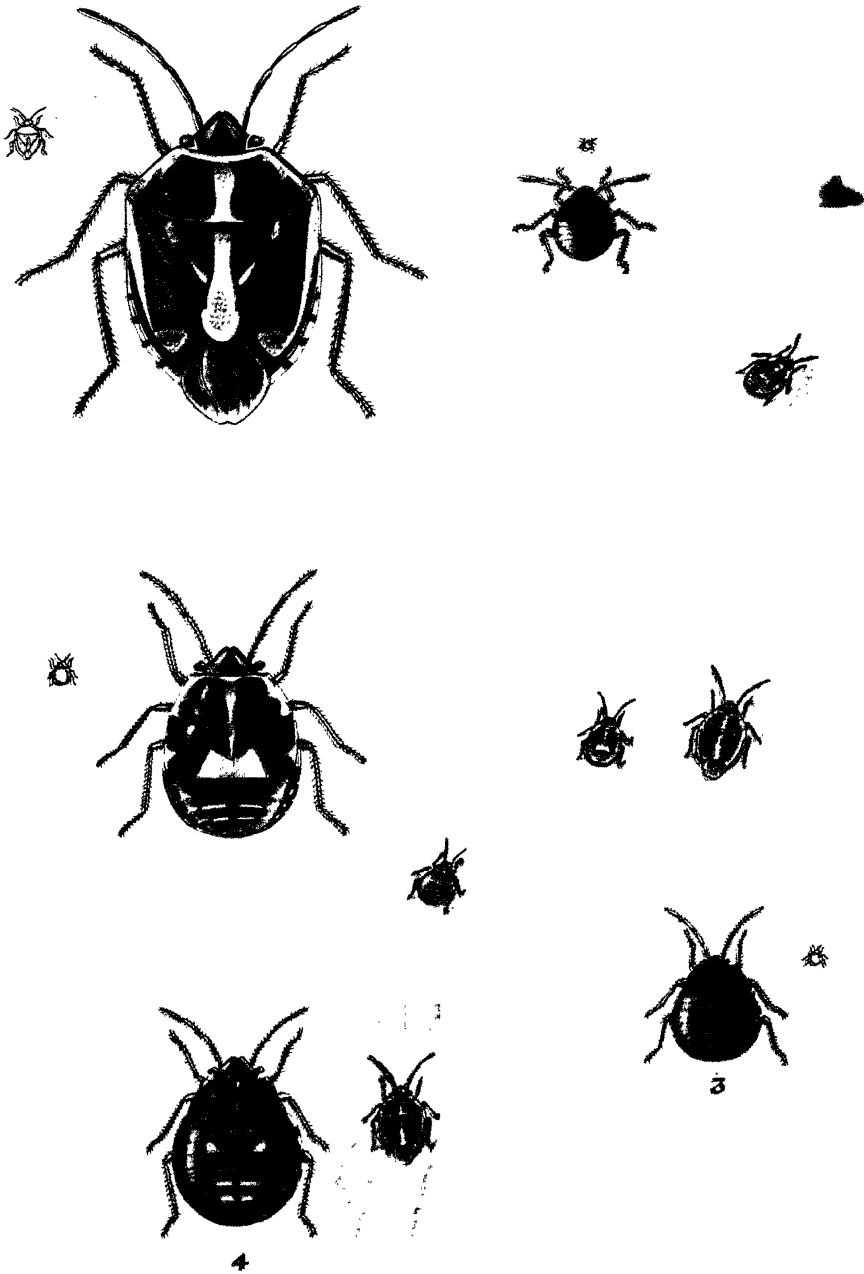
It is only occasionally that it occurs in large numbers on young mustard and damage may be caused when the crop is allowed to flower and fruit.

THE STRIPED LEAF-ROLLER AND BORER.

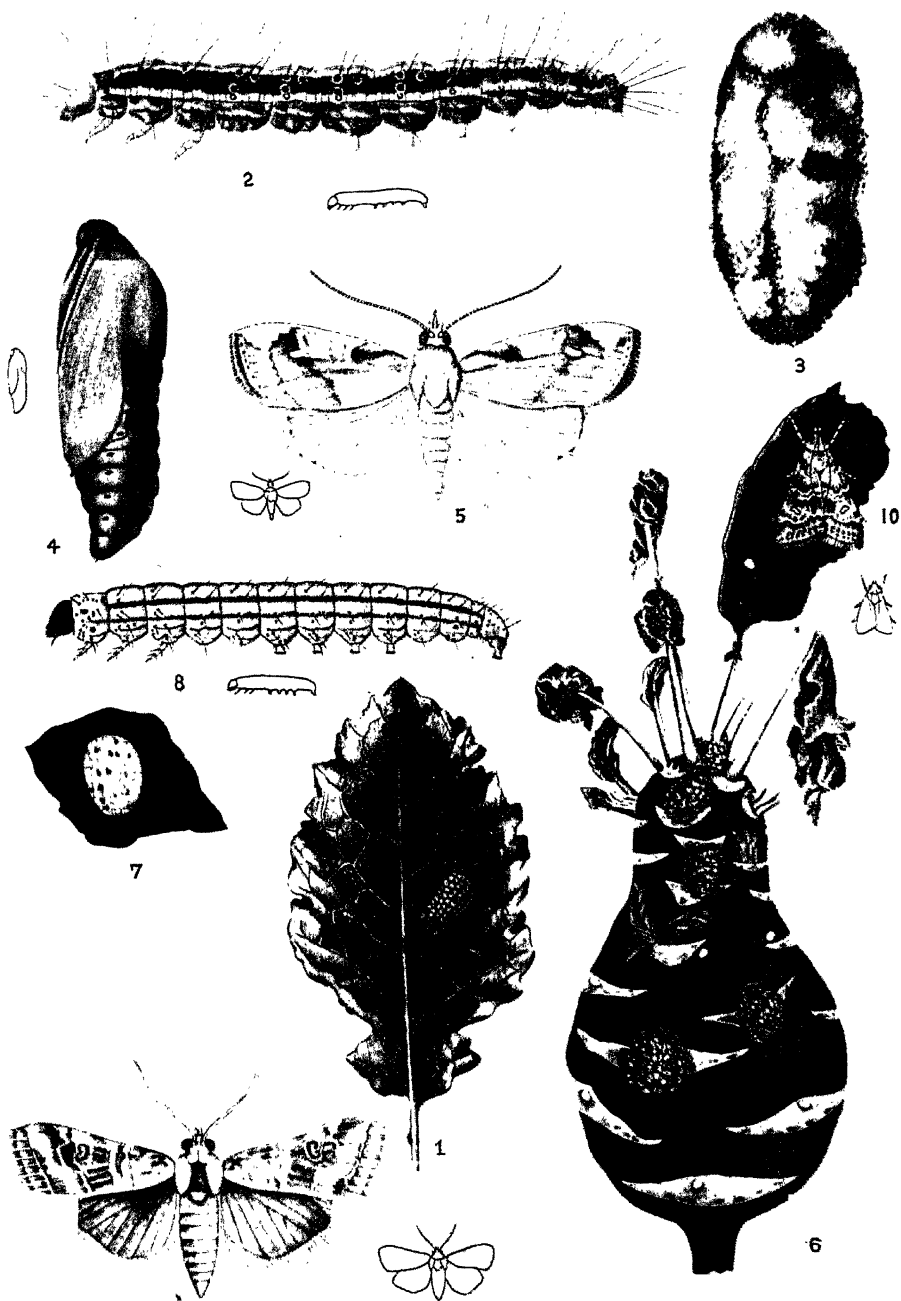
(*Hellula undalis* Fb.)

Plate 61, Figs. 6 to 10.

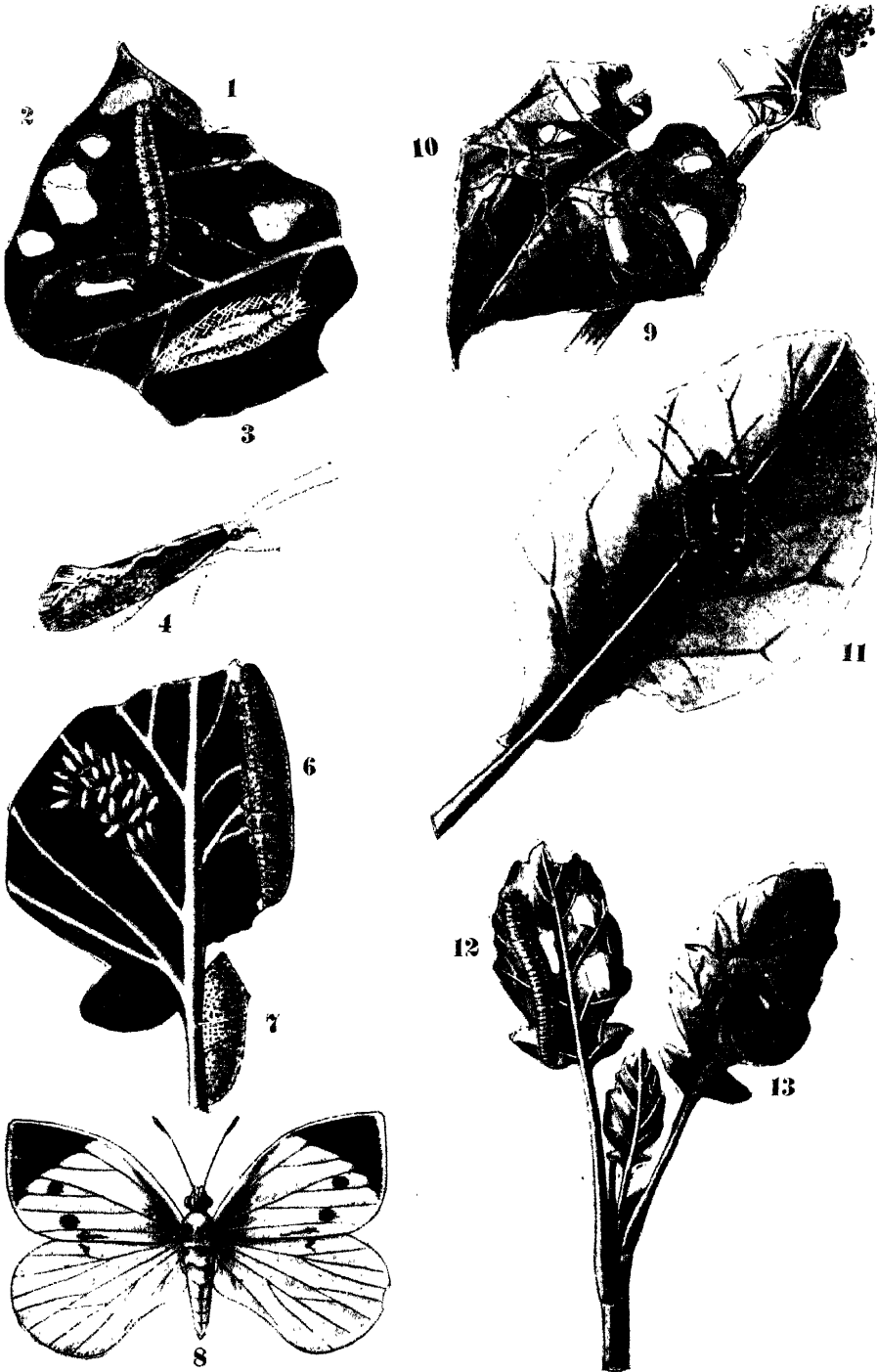
This caterpillar (Fig. 8) with parallel stripes on its back behaves both as a leaf roller and as a borer of stems, pods and roots. Fig. 6 shows how the leaves of beet have been rolled and damaged and the



The Painted Bug
(*Bagrada picta*)



Mustard Caterpillar (*Crocidolomia binotalis*)
and Striped Leaf-roller and Borer (*Hellula undalis*)



Pests of vegetable crops

masses of frass on the root indicates where the caterpillars have bored into it and thrown out frass webbed together with silk. Mustard leaves are rolled in the same way and pods bored. When fullgrown the caterpillar pupates in a cocoon made with frass and ultimately issues as a moth (Fig. 9 in flying, and 10 in sitting postures). The moth lays eggs singly on leaves, stems and roots of the food plants as shown in Fig. 6. The caterpillars hatch from these eggs. The life-cycle takes about three to four weeks, *viz.*, egg three days, larva about two weeks and pupa about a week.

This pest usually proves injurious late in the season and occurs on beet, cabbage, cauliflower, radish, knol-kohl, etc. The affected plants easily recognizable on account of masses of frass thrown out, should be uprooted, cut into pieces, boiled and fed to cattle.

THE DIAMOND BACK MOTH.

(*Plutella maculipennis* Curt.)

VERNACULAR AND LOCAL NAME.—*Po-sein-gaung* (Kyauksè).

Plate 62, Figs. 1—4.

A slender small green caterpillar feeds by biting holes in leaves and also by boring pods of mustard and flower heads of cauliflowers. Sometimes it occurs in large numbers causing appreciable damage. When fullgrown it spins an open-meshed net-like cocoon on leaves or stems and transforms into a pupa in this cocoon. The moth, which exhibits characteristic diamond-shaped markings on its back when sitting, develops from the pupa and lays small eggs on leaves and stems. The caterpillars hatch from these eggs.

Hardly any steps are necessary on mustard.

On Radish.

The pests described and illustrated under mustard occur on this crop but do not cause much damage.

The Common Hairy Caterpillar (Plate 32) and the Green Semilooper (Plate 34) may also occur.

On Cabbage and Cauliflower.

These are important vegetables and require care in growing but are subject to damage by several pests.

ANTS IN SEED BED.

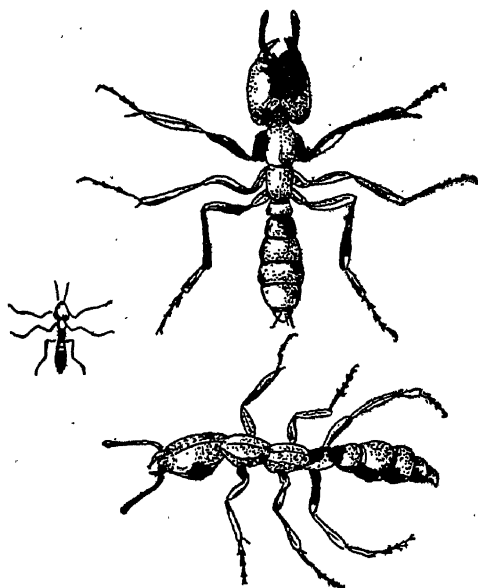
Germinating seeds are liable to be carried off by ants but become immune after germination. Therefore protection is necessary only for a

few days during germination. This is very effectively given in the following manner. On the top of the seed bed spread about half an inch layer of sand or powdered earth in which kerosene oil has been mixed at the rate of a pint in a kerosene tin-full of sand or earth. Over this layer spread the earth in which to sow the seeds. Water may be sprinkled on the seed bed if necessary.

THE GROUND RED ANT.

(*Dorylus orientalis* West-Wood.)

VERNACULAR AND LOCAL NAME.—*Cha-ni-gaung* (Papuñ).



Text Fig. 57.

GROUND RED ANT (*Dorylus*) (AFTER I. M.N.).

The Ground Red Ant frequently attacks transplanted seedlings, cutting roots and killing the plants.

They should be kept off by watering the soil with kerosene emulsion or crude oil emulsion solution.

Occasionally termites or white ants behave in the same manner but can be kept off in the same way.

WHITE GRUBS.

Plate 7.

Chafer grubs present in the soil may cut the young plants. The soil requires to be well prepared and farmyard manure which may be applied should be well sifted and searched for grubs before application.

CUTWORMS.**(*Agrotis ypsilon*.)****Plate 33.**

Cut worms cut young plants and require to be removed out by raking up and searching the soil. The plants can also be protected by bamboo cylinders (Text Fig. 58).

**Text Fig. 58.**

PROTECTION AGAINST THE LARGE BROWN CRICKET AND CUTWORMS.

THE LARGE BROWN CRICKET.**(*Brachytrypes portentosus*.)****Plate 3.**

The Large Brown Cricket cuts plants. They can be forced out by pouring water into their holes and can then be destroyed. The plants can be protected by bamboo cylinders (Text Fig. 58).

THE WHITE BUTTERFLY.**(*Pieris canidia* Sparrm.)****Plate 62, Figs. 5—8.**

This hairy caterpillar may occur in large numbers devouring leaves. The caterpillars are hatched from eggs laid on the leaves by the white butterfly and when fullgrown transform into chrysalids which are fixed on leaves or stems. The butterflies emerge from the chrysalids. The life-cycle takes about four weeks.

Eggs can be crushed between the fingers. If this is done in time there will be no caterpillars to damage leaves. The caterpillars and chrysalids are easily seen and are best picked off. The butterfly can be caught in hand nets.

THE TOBACCO CATERPILLAR.**(*Prodenia litura* Fb.)****Text Fig. 59.**

The Tobacco Caterpillar occasionally occurs eating leaves and also boring the heads and flowers but can be easily controlled if proper watch is kept on the plants. (See under tobacco.)

THE MUSTARD SAW FLY.**(*Athalia proxima*.)****Plate 59 and Plate 62, Figs. 12—13.**

The sooty-black saw fly grubs sometimes cause damage to young plants and are best picked off.

THE DIAMOND BACK MOTH.**(*Plutella maculipennis* Curt.)****VERNACULAR AND LOCAL NAME.—*Po-sein-gaung* (Kyauksè).****Plate 62, Figs. 1—4.**

The small green caterpillars of this moth may nibble leaves but they are a pest on cabbage and cauliflower as they bore the heads and flowers. They should be watched and picked off from the beginning so as not to let their numbers increase. They can also be controlled by spraying with rosin compound solution.

Aphis.**Plate 1.**

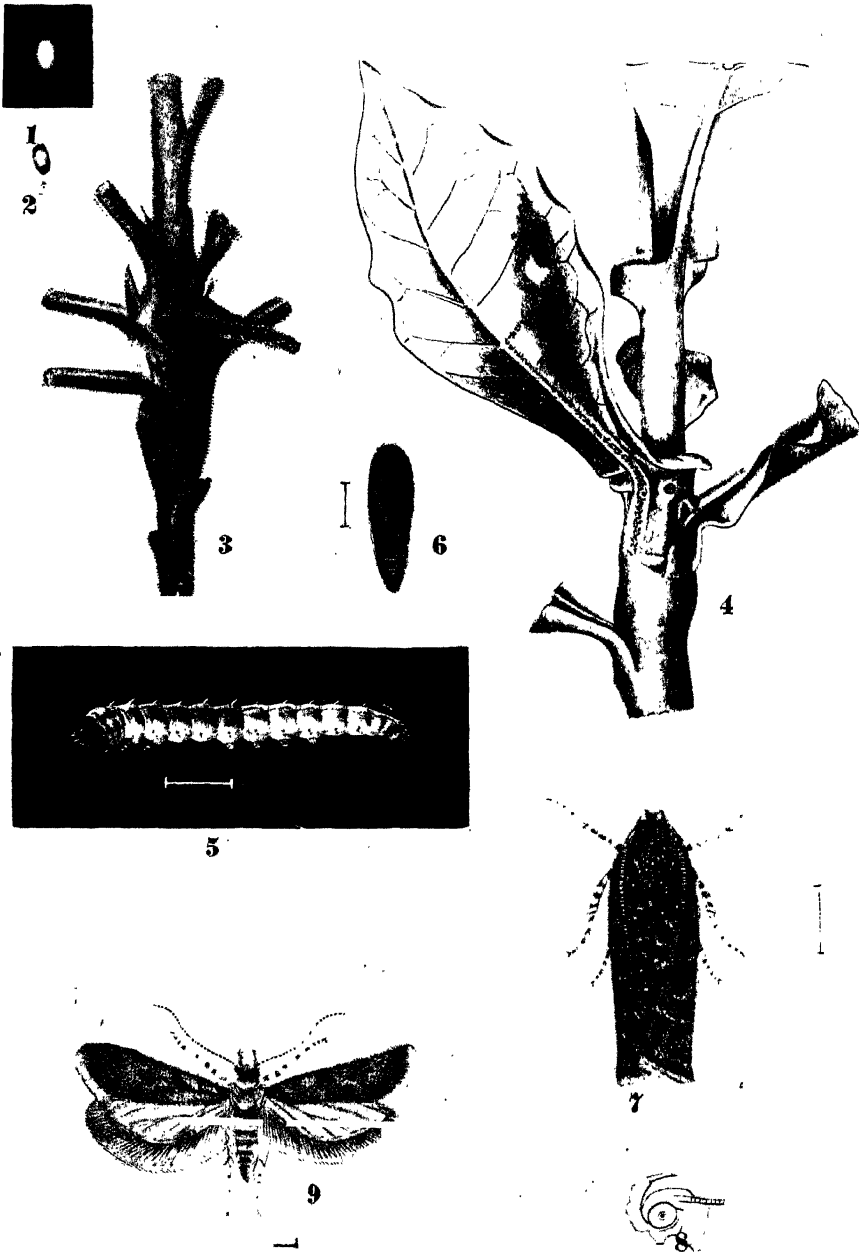
Aphis frequently occurs but can be easily controlled (see under general pests).

THE GREEN SEMILOOPER.**(*Plusia orichalcea*.)****Plate 34.**

The Green Semilooper caterpillar occasionally occurs on leaves but can be picked off.

THE MUSTARD CATERPILLAR.**(*Crocidolomia binotalis*.)****Plate 61, Figs. 1 to 5.**

This caterpillar may occur but is seldom bad.



The Tobacco Stem Borer
(*Phthorimaea heliopa*)

THE STRIPED LEAFROLLER AND BORER.

(Hellula undalis.)

Plate 61, Figs. 6 to 10.

This pest frequently proves injurious to fully grown cabbages and cauliflowers boring the heads and flowers and specially stems in which it often occurs in large numbers. Such plants are best used up quickly and the stems uprooted, cut up, boiled and fed to cattle. Infested stems left standing enable the pest to breed and increase in number.

KNOL-KOHL, TURNIP, BEET ROOT, LETTUCE, CELERY, CARROT and other vegetables usually grown in the winter season along with cabbage and cauliflower may suffer from one or other of the insects described above.

PESTS ON SOLANACEOUS CROPS.

ON TOBACCO.

In the seed bed flea beetles bite holes in leaves and the stem borer caterpillar (Plate 63) causes swelling in the stem and retards growth.

Transplanted plants are cut by Cutworms (Plate 33) especially in *kyun* lands and river banks liable to be submerged every year and the Large Brown Cricket (Plate 3).

Aphis is occasionally bad covering entire plants.

Later on an insect which occurs on leaves and bites holes in them causes the tobacco to deteriorate in value and is therefore to be considered a pest. Several such insects occur.

THE TOBACCO STEM BORER.

[*Phthorimæa (Gnorimoschema) heliopa* Low.]

VERNACULAR AND LOCAL NAME.—*Ayoh-sa-fo* (Thayetmyo).

Plate 63.

This caterpillar (Fig. 5) bores inside the stem and due to this irritation the bored part of the stem swells (Figs. 4 and 3). When full-grown the caterpillar gnaws an opening for the future moth to emerge easily, and covering the mouth of the hole with silk transforms into a pupa in the bored stem (Fig. 6). The moth (Fig. 7 in sitting and 9 in flying postures) lays eggs (Fig. 1) on leaves and stems. The young caterpillar on hatching from the egg bores into the tissue and, if on a leaf, mines its way into the stem through veins (Fig. 4). The life-cycle ordinarily takes about five weeks, viz., egg 3 days, larva about 20 days

and pupa about a week. A single female lays about 500 eggs. When cold is severe the insect hibernates as a pupa.

The pest appears early in seed beds. The seedlings with swollen knots should be uprooted and either buried underground or burnt so as to prevent the pest from increasing in number. The pest appears on growing tobacco also and retards growth. A longitudinal slit with a thin bladed knife in the swelling usually injures and kills the caterpillar and the plant resumes growth.

CUTWORMS.

Plate 33.

It is necessary to weed out and collect the caterpillars and throw them into deep water or kill them.

THE LARGE BROWN CRICKET.

Plate 3.

The crickets are collected and eaten by the people. Therefore there is an inducement towards its destruction.

The transplanted plants can be protected by inserting into the soil a bamboo cylinder as shown in text figure 58. For easy insertion and removal when the plant has outgrown the vulnerable stage the cylinder can be slit into two halves. The cylinder also affords protection against cutworms.

THE TOBACCO CENTRAL LEAF CATERPILLAR.

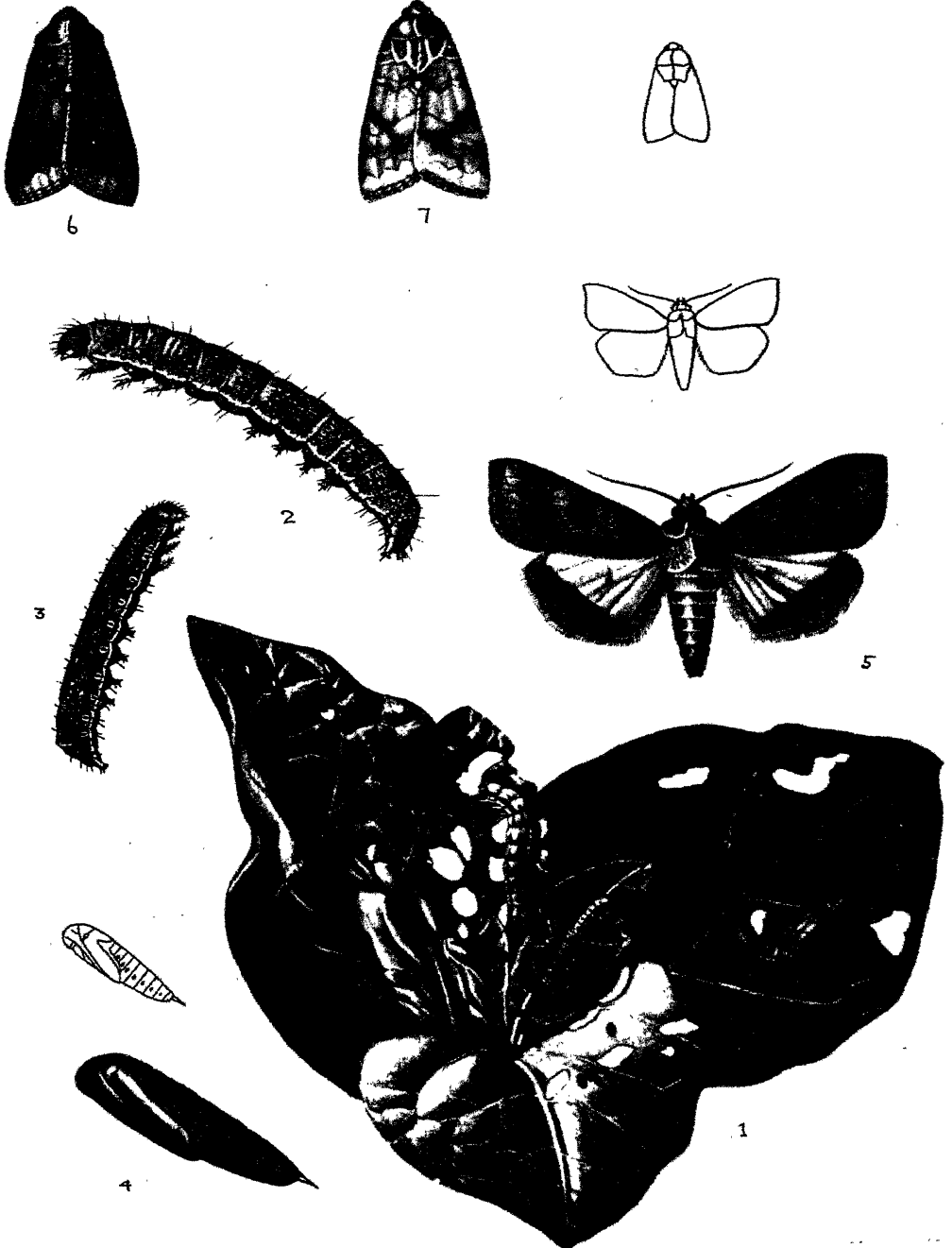
[*Heliothis (Chloridea) assulta* Guen.]

VERNACULAR AND LOCAL NAMES.—*Daungde*, *Aywet-sa-po* (Thayetmyo).

Plate 64.

The caterpillars occur on growing and grown tobacco (Figs. 1, 2 and 3) persistently and eat the central leaves biting holes in them and covering them with black pellets of excreta (Fig. 1). When fullgrown they go down into the soil and there transform into pupæ (Fig. 4). Some issue as moths (Figs. 1, 5, 6 and 7) after about five or six days but some hibernate and aestivate in the pupal state and issue as moths between the following March and July. The moth lays eggs on leaves and from these eggs the caterpillars hatch. The life-cycle ordinarily occupies about three to four weeks but in the case of those which hibernate and aestivate it may extend to about eight or nine months. Each female moth lays about 300 eggs.

The presence of the caterpillars which feed openly is easily detected by the black pellets of excreta on the leaves by one walking



Tobacco Central Leaf Caterpillar
(*Chloridea assulta*)



1



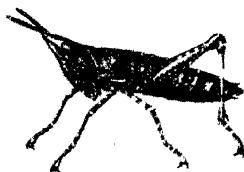
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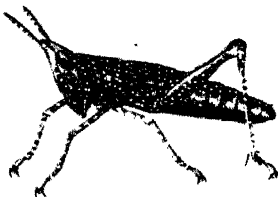
3



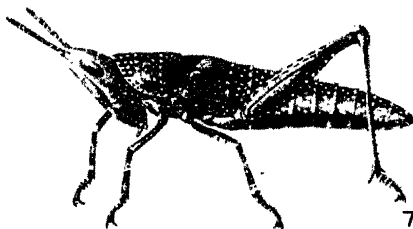
4



5



6



7



8



10



9

Tobacco Grasshopper

between the rows of plants and they should be collected and disposed of. This simple method should be carried out regularly thus preventing damage and increase of the pest.

GRASSHOPPERS.

(*Atractomorpha crenulata* Fb.)

Plate 65.

Several short-horned and long-horned grasshoppers eat and bite holes in tobacco leaves. The life-history of the one illustrated in the plate is typical.

Adult grasshoppers, that is, those with wings fully developed (Fig. 9) deposit eggs in the soil in holes excavated by inserting the hind end of the body into the soil (Fig. 1 egg cluster in the soil, Fig. 2 egg cluster removed from soil and Fig. 3 one egg shown enlarged). Eggs are deposited in clusters and the cluster as well as the hole are covered by a frothy substance exuded with the eggs. This frothy substance on drying holds the cluster intact and also serves as its protection. Young grasshoppers (Fig. 4) on emerging from the eggs work their way out and are able to hop about and eat leaves in the same way as adults do. They feed and grow gradually, casting off skins at intervals and developing wing pads with growth. Figs. 4 to 8 show gradual growth and development at the several moults. After the final moult wings are fully developed and the grasshopper attains the adult state and can both jump and fly. In the case of this grasshopper eggs hatch in about 10 days and the nymph takes about 45 days to attain the adult state. Adults mate and lays eggs, each female laying about 100 eggs. Adults live for about two to three months.

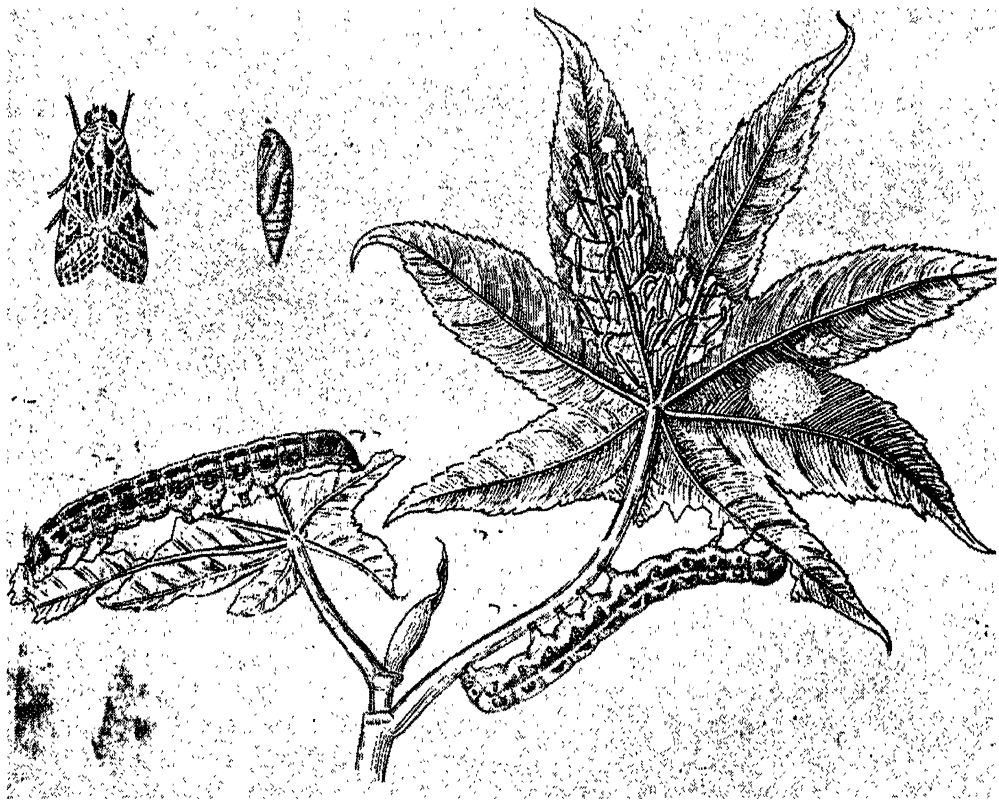
This is typical of the life-history of all short-horned grasshoppers among which the dreaded and well-known locusts are also included. In the case of different grasshoppers the periods of egg and nymphal stages are different.

Both nymphs and adults usually move about by taking long jumps with the help of their hind legs which are adapted for jumping. These legs are also armed with sharp spines which are thrust into and may prick the skin when the grasshopper is caught by hand. A small hand net should be used in collecting nymphs and adults of grass-hoppers occurring on and causing damage to tobacco. They should be crushed.

THE TOBACCO CATERPILLAR.

(Prodenia litura Fb.)

VERNACULAR AND LOCAL NAME.—*Po-naga*, i.e., dragon-like insect
(Thayetmyo).



Text Fig. 59.

THE TOBACCO CATERPILLAR (*Prodenia litura*) FEEDING ON CASTOR LEAF.

EGG CLUSTER, YOUNG GREGARIOUS AND GROWN UP CATERPILLARS ON LEAF; PUPA AND MOTH SITTING,
(ALL MAGNIFIED ABOUT TWO TIMES.)

This caterpillar, unlike the Central Leaf Caterpillar only a few of which may occur in a plant, appears in the early stage in swarms on leaves. This is due to the fact that several hundred eggs are deposited in a cluster which is covered with

buff-coloured hairs and there may be several clusters of eggs on a single plant. The young caterpillars which hatch from these eggs remain and feed gregariously at first on the tissue of the leaf leaving one surface entire like the Common Hairy Caterpillars (Plate 32). When they are about one-third or somewhat more grown they spread and feed by biting the leaves. When full-grown they go into the soil and transform into pupae. Moths emerge from the pupae. The life-cycle takes about one month, *viz.*, egg 3 to 4 days, larva 21 days and pupa 6 days. Each female moth lays about 500 eggs.

This pest is not a regular or persistent one but occasionally occurs in large numbers causing immense damage unless checked in time.

The caterpillars are known to feed on cotton, castor, brinjal, cabbage, etc., and the pest may appear on any of these plants. In Egypt it is a serious pest on cotton but here it rarely occurs on that crop.

If a regular watch is kept on the crop hardly any damage can be caused by this pest. Egg clusters are easily visible and can be crushed between fingers or a bit of the leaf containing the cluster can be torn off and either buried underground or burnt. The gregarious young caterpillars too are easily visible and can be removed with the leaf and similarly disposed of. Grown up caterpillars have to be looked for and collected by hand.

THE COMMON HAIRY CATERPILLAR.

Plate 32.

Hairy caterpillars occasionally occur on this crop but can be easily controlled according to the methods described at page 95.

THE GRAM POD BORER CATERPILLAR.

Plate 35.

This caterpillar occasionally occurs on tobacco kept for seed and bores the seed capsules, eating the seeds, and requires to be picked off and destroyed.

ON POTATO.

The common pests occurring on this crop are the following :—

Cutworms which cut plants—for details about this pest see Plate 33 and page 96.

The Large Brown Cricket also cuts plants—for details about this pest see Plate 3 and page 9.

Epilachna beetles and their grubs eat leaf tissue and in bad cases cause the death of the plants. For details about these pests see Plate 67 and page 141.

The Green Bug (Plate 40) occasionally breeds on the plants and when large numbers of bugs and their nymphs occur the loss of sap due to their sucking weakens the plants seriously though no external damage is observable.

Aphids, flea beetles and mites may occur occasionally. They have been treated of under general pests.

There are other pests on this crop described below.

THE POTATO TUBER BORER.

(*Phthorimæa operculella* Z.)

Plate 66.

This caterpillar (Figs. 6 and 11) is a serious pest of potato. The potato plant in the plate shows how it can cause damage by mining leaves producing dead patches in them and boring shoots and stems causing wilting. Tubers both in the field if exposed and in the store are bored. On tubers eggs are usually laid at the eyes (Fig. 12) and as the caterpillars bore in a quantity of frass collects at the eyes (Fig. 3). How the tubers are bored is shown in Figures 4 and 5 of tubers cut into two. When full-grown the caterpillars pupate (Fig. 10) in the tunnels and ultimately issue as moths (Figs. 2, 7, 8 and 9). The life-cycle takes about 4 to 5 weeks, viz., egg 3 to 4 days, larva 20 to 25 days and pupa 7 to 10 days. Each female moth lays about 300 eggs. Moths are not met with during the day time and fly at night.

It is a pest principally on tubers and occurs on plants rarely. It is the tubers which require to be protected. Care should be taken to keep tubers in the field covered with earth. If they are exposed and thus run the risk of being infested, the pest has a chance of being introduced into the store where it finds full facilities for breeding.

The best means of storing potatoes is in layers covered wholly with dry sand.

THE GROUND RED ANTS.

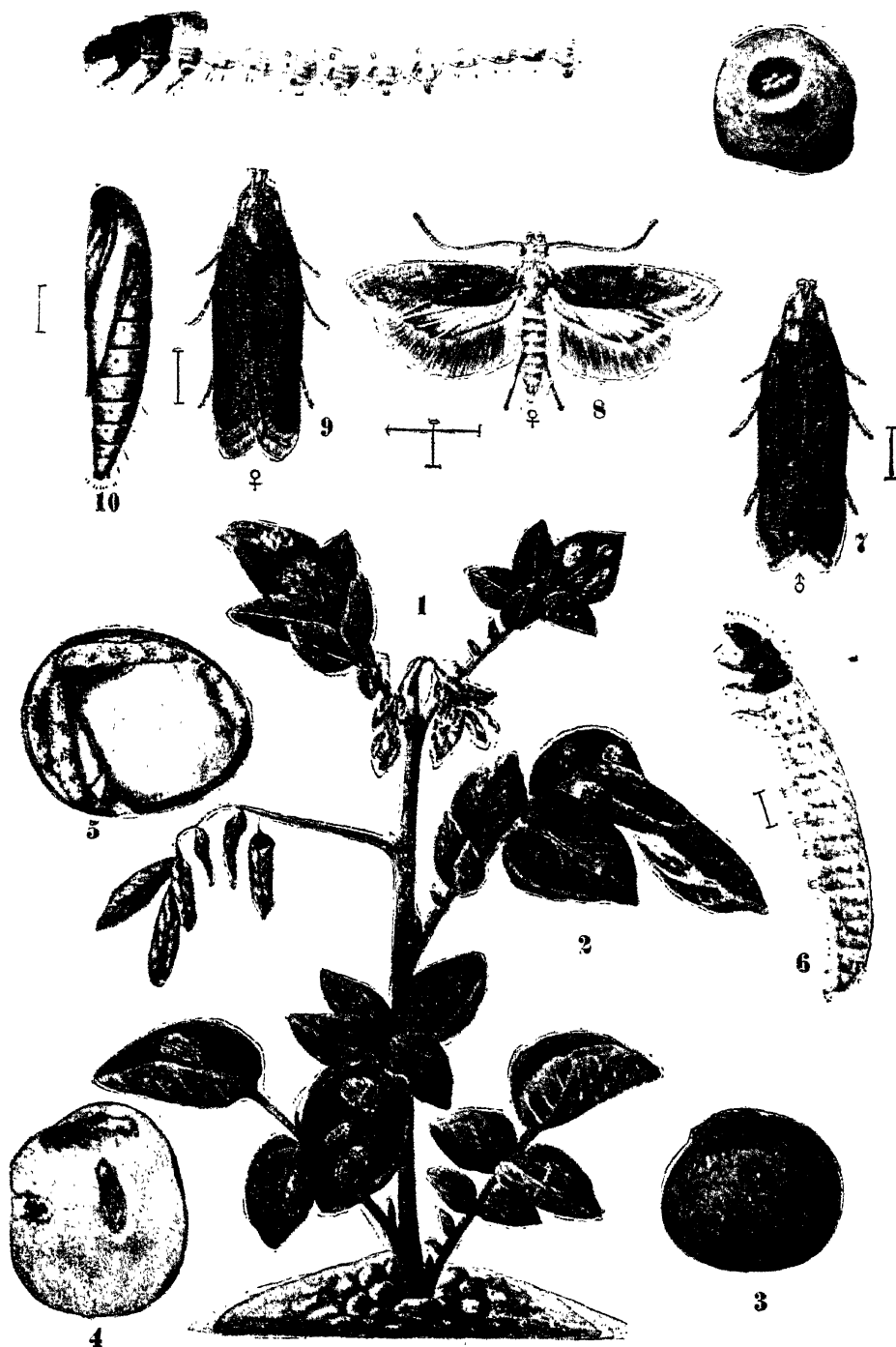
(*Dorylus orientalis*.)

VERNACULAR AND LOCAL NAMES.—*Cha-ni-gaung*, i.e., red termite ;
Dosheli (Leiktho-Gebba Karen).

Text Fig. 57.

Occasionally Ground Red Ants bore potato tubers in vegetable gardens but rarely in the field.

In vegetable gardens it is possible to use a repellent in the form of kerosene emulsion or crude oil emulsion water poured or run into the soil between rows of potatoes.



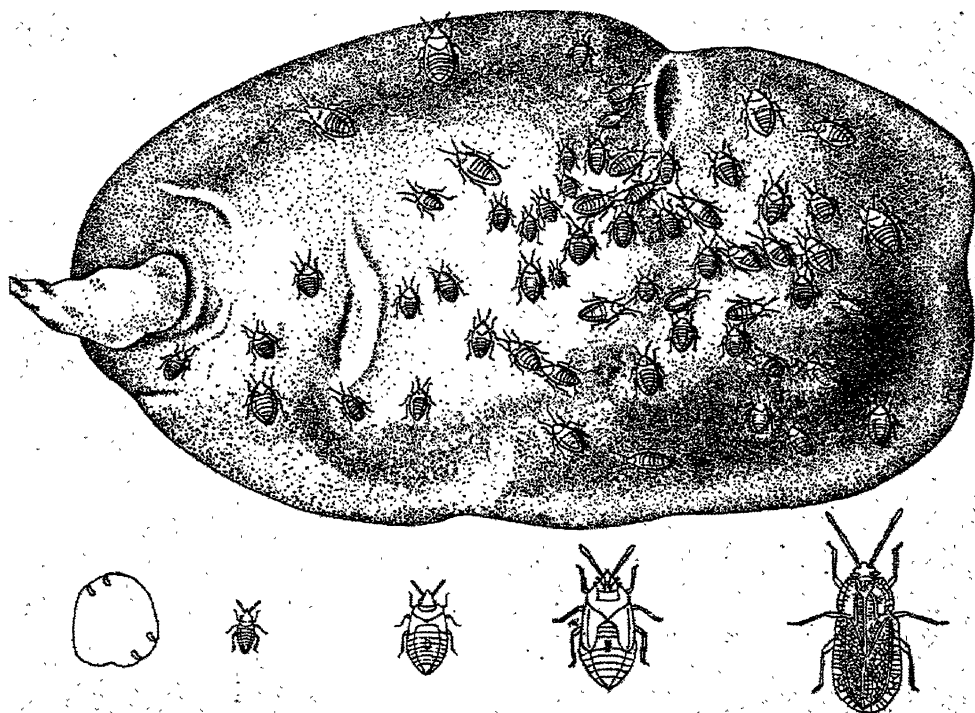
The Potato Tuber Borer
(*Phthorimæa operculella*)

On potato in store.

Potato in store suffers from three insects. The most serious is the Potato Tuber Borer. The other two are a Lace-wing bug and a Mealy bug.

THE POTATO LACE-WING BUG.

(*Recaredus* Sp.)



Text Fig. 60.

THE POTATO LACE-WING BUG.

YOUNG BUGS ON A TUBER; BELOW A PIECE OF A TUBER CUT TO SHOW HOW EGGS ARE INSERTED, A YOUNG BUG, DEVELOPING NYMPHS AND ADULT BUG.
(ALL MAGNIFIED ABOUT FIVE TIMES.)

This small lace-wing bug has the general life history like those of other bugs. It inserts eggs into the tubers. The young nymphs which hatch out of these eggs in about 10 days feed by sucking the potato juice

like the adult bugs and along with these. They gradually grow and develop wing pads finally attaining the adult state at the fourth moult in the course of about three weeks when the wings are fully developed. Adult bugs live up to about four months.

The bugs feed and breed forming large colonies and covering the tubers.

Destruction of the first colonies if observed in time may stop its increase. Spraying with or dipping the tubers in strong rosin compound solution and drying them before storage again rids the tubers of the pest. Two treatments may be necessary as eggs are not affected by the treatment.

THE POTATO MEALY BUG.

(*Pseudococcus nispæ* Mask).

Plate 11, Figs. 12—13.

Potatoes in store especially later in the season in sprouting condition may be infested by this mealy bug.

Spraying with or dipping in strong rosin compound solution is an effective cure.

ON BRINJAL.

Out of the general pests aphids and mites and a flea beetle frequently occur on brinjal leaves. Mealy bugs may also occur on leaves as well as on shoots.

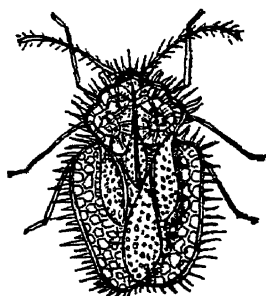
ANTS AFFECTING SHOOTS AND LEAVES.

(*Solenopsis geminata* Fb.)

A small ant attacks tender shoots and leaves causing them to wilt. The ants have their nest in the ground and are observed moving up and down the plants. The soil at the bases of the plants should be watered with kerosene emulsion or crude oil emulsion water so as to impart a smell of kerosene to it which will keep the ants off. When practicable a band on the stem with rag soaked in crude oil emulsion prevents them from climbing.



THE BRINJAL LACE-WING BUG.

(Urentius echinus Dist.)

Text Fig. 61.

BRINJAL LACE-WING BUG (*Urentius echinus*) (AFTER DISTANT).

This small flat bug with reticulated lacelike wings frequently occurs and breeds on the leaves. The detailed life-history is similar to that of the Potato Lace-wing Bug illustrated in Text Fig. 60. Eggs are laid on the leaves and both the nymphs and the adults feed by sucking juice gregariously covering the leaves. In case of large infestation the plants are weakened, sometimes seriously, due to loss of sap.

The plants can be freed of the pest by being sprayed or wetted with rosin compound solution.

THE EPILACHNA BEETLES AND THEIR GRUBS.

(*Epilachna dodecastigma* Muls., and *Epilachna viginti-octo-puncta* Fb.)

VERNACULAR AND LOCAL NAMES.—*Po-leik-kya*, i.e., striped or spotted tortoise-like insect (Thayetmyo); *Po-nei-pyak*, i.e., red insects with spots (Tavoy).

Plate 67, Figs. 10 to 12.

These two lady-bird beetles (Fig. 13), one 12-spotted and the other 28-spotted although related to the beneficial lady-bird beetles which prey upon aphids are serious pests of several plants, viz., brinjal, potato, cowpea, etc.

The beetles themselves damage leaves by nibbling the leaf-tissue in a characteristic manner shown in the plate. They further breed on the plants depositing clusters of cigar-shaped yellow eggs (Fig. 10) on the leaves. The grubs (Fig. 12) on hatching from these eggs feed on the leaves in the same way as the beetles. As many grubs generally occur together damage is almost always severe unless control measures are adopted in time. The nibbled leaves dry. The grubs are spiny and can hardly be mistaken. When full-grown they attach themselves

by their hind end to leaves and stems and transform into pupæ (Fig. 12) from which the beetles develop. The life-cycle takes about three weeks. The beetles live about two months and each female lays about 200 eggs. The period of the life-cycle is fairly short. Therefore the number of grubs and beetles increases fairly rapidly.

As soon as beetles are observed to appear, as will be evident from the characteristic discoloured patches on the leaves, they should be caught and destroyed. Egg-clusters should be looked for and crushed between the fingers. Grubs should be picked off and destroyed. Grubs succumb to a spray of strong rosin compound solution. If the beetles and eggs are destroyed no grubs will appear.

THE BRINJAL LEAF ROLLER.

(*Eublemma olivacea* Wlk.)

Plate 68.

A hairy semilooping caterpillar possessing a red colour or red tinged with violet (Figs. 4 and 5) rolls up leaves and feeds from inside the roll causing the infested leaves to dry as shown in the plate. When full-grown it transforms into a pupa (Fig. 6) inside the infested leaves and ultimately issues as a moth (Figs. 7 in sitting posture and 8 in flying posture). The moth deposits hairy globular brown-coloured eggs (Figs. 2 and 3 enlarged) in clusters on the leaves (Fig. 1). The caterpillars hatch out of these eggs in about 5 days and feed for about 3 weeks before pupation. The pupa takes about 8 days to develop into moths. Each female moth lays about 100 eggs.

The infested leaves, especially freshly rolled ones, may be unrolled and the caterpillars destroyed or they may be plucked off and buried underground.

LEAF BINDING CATERPILLARS.

(*Phycita clientella* Z. and *Pachyzancla bipunctalis* Fb.)

Two kinds of caterpillars, one binding together the top leaves in the same way as those of cotton (see Plate 43) and the other both top and other leaves, sometimes occur on brinjal. The bound leaves dry and usually harbour several and, in the case of the second species, many caterpillars. The caterpillars hatch from eggs laid by moths and in their turn develop into moths again.

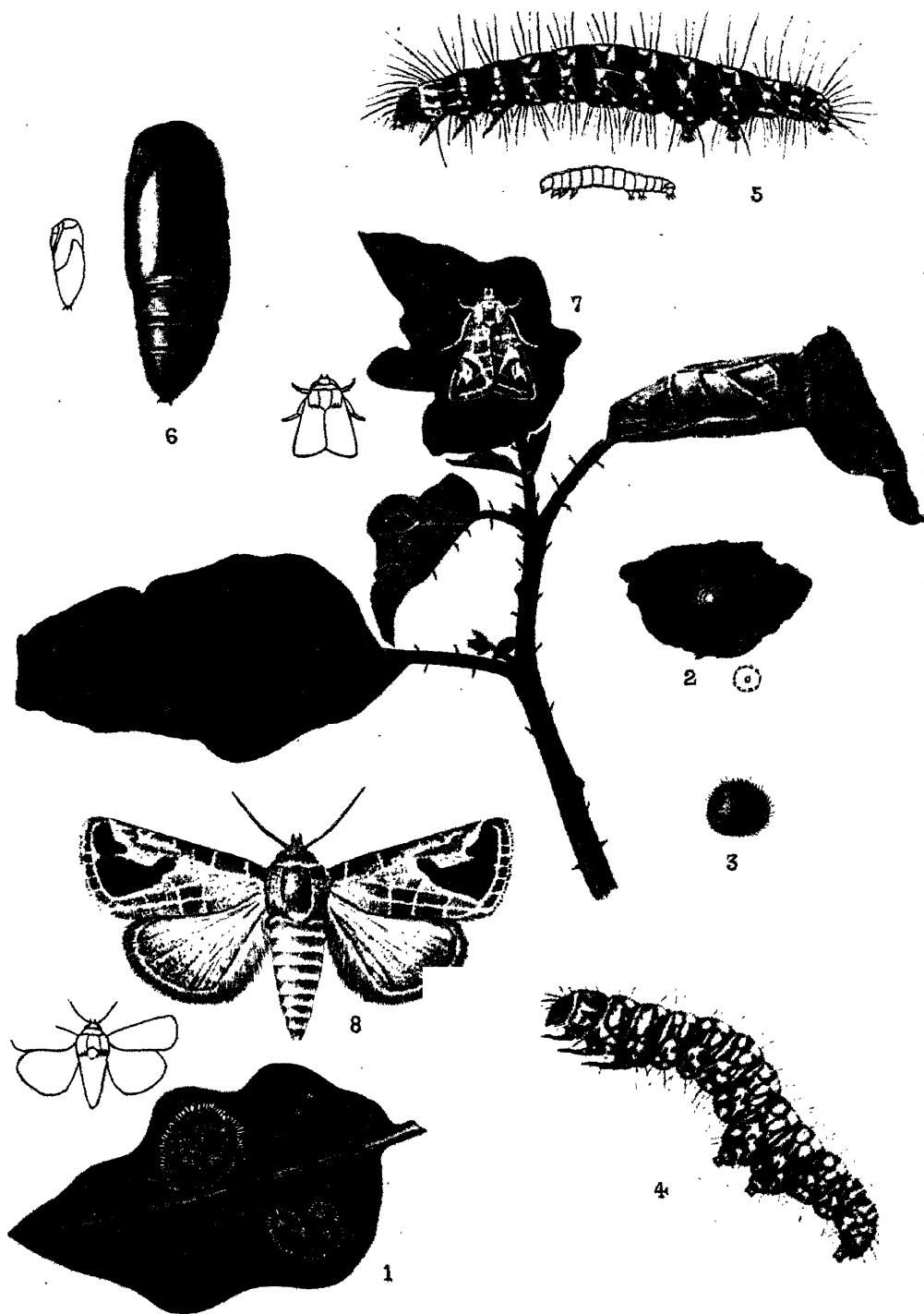
The bound leaves should be cut off and either buried underground or burnt.

THE DEATH'S HEAD MOTH CATERPILLAR.

(*Acherontia styx*.)

Plate 51.

This large hawk moth caterpillar sometimes occurs, devouring leaves, but is easily seen and can easily be disposed of.



Brinjal Leaf-roller
(*Eublemma olivacea*)

THE BRINJAL SHOOT AND FRUIT BORER.**(*Leucinodes orbonalis* Guen.)****Plate 67, Figs. 5 to 9.**

Before the plants begin to bear fruits the caterpillar (Fig. 5) bores the shoots which are caused to wilt (Fig. 6). Later it persistently bores the fruits which show holes and frass is thrown out through these holes. The pest occurs widely and bored fruits are common. When full-grown the caterpillar leaves the bored fruits or shoots and forms a brown-coloured cocoon on the stem, in the fold of a leaf or in the ground (Fig. 7) and turns into a pupa (Fig. 8) inside the cocoon. The moth (Fig. 9), a pretty insect, develops from the pupa and issues out of the cocoon. Eggs laid by the moth give rise to the borer caterpillars. The life-cycle takes about three weeks, *viz.*, egg about 3 days, larva about 12 to 15 days and pupa about 5 days. Each female moth lays about 200 to 300 eggs.

Moths are frequently found on the plants and should be caught and destroyed. Wilted shoots should be cut off and either crushed or burnt. The bored fruits should be plucked and used up. The common practice is to reject the bored portions of fruits and throw them away and the caterpillars have a chance of developing into moths. The rejected fruits should be fed to cattle at once.

BRINJAL HAIRY CATERPILLAR.**(*Plotheia nephelotis* Meyr.)**

Occasionally a caterpillar with long tufts of hairs projecting forward and behind occurs on leaves and feeds gregariously. They hatch from eggs laid by moths and in their own turn develop into moths again.

The leaf containing them should be plucked off and buried underground.

BRINJAL STEM BORER.**(*Euzophora perticella* Rag.)****Plate 67, Figs. 1 to 4.**

A caterpillar (Figs. 1 and 2) bores the main stem of brinjal plants throwing out frass and when fullgrown transforms into a pupa in the tunnel (Fig. 3) ultimately issuing as a moth (Fig. 4.) The pest is of rare occurrence but should be guarded against. The holes through which frass is thrown out should be probed with a wire. The caterpillar dies if pricked and cannot develop into the moth. Carbon bisulphide can also be injected in small quantities. The pest occasionally occurs on chillies and tomato.

ON TOMATO.

Tomato in favourable seasons hardly suffers from insect pests. In unfavourable seasons mites and aphids may occur on it.

Occasionally the Tobacco Caterpillar (Text Fig. 59) and *Epilachna* beetles and their grubs (Plate 67, Figs. 11 and 12) occur on the leaves.

The Gram Pod Borer caterpillar (Plate 35) occasionally bores fruits.

ON CHILLIES.

Chillies are a fairly resistant crop. Transplanted young plants may occasionally be cut by the Large Brown Cricket (Plate 3) and in unfavourable seasons the plants may suffer from aphids, thrips and jassid bugs (see general pests).

PESTS ON CUCURBITACEOUS PLANTS.

The Red Pumpkin Beetle.

(*Aulacophora foveicollis* Lucas.)

Plate 69.

This red beetle (Figs. 5 and 6 enlarged) attacks and bites holes in the leaves of seedlings which may be killed. The beetles themselves are serious pests of all cucumbers, melons, pumpkins and gourds in their seedling and young stage.

They can, however, be kept off by sprinkling kerosenised ashes on the leaves regularly. As the beetles congregate where such seedlings are present they should also be caught with hand nets and destroyed.

The beetles lay eggs in the soil (Fig. 1) and the grubs (Figs. 2, 3 and 7) which hatch from these eggs feed on roots, old fallen leaves and occasionally bore stems and fruits, especially of melons lying on the ground. The grubs therefore prove occasionally harmful, killing off plants by boring the stems and destroying fruits. When full-grown they form pupal cells underground with agglutinated earth and transform into pupae (Fig. 4). Beetles develop from the pupae. The life-cycle takes about 4 to 5 weeks, *viz.*, egg about a week, larva about 2 to 2½ weeks and pupa about 8 to 10 days. The beetles have been observed to live for about eight months in confinement.

Where grubs attack melon fruits care should be taken to raise the fruits from the soil out of reach of the grubs. There is another beetle of a bluish-black colour (Plate 62, Fig. 10) which also attacks seedlings but occurs in much smaller numbers.

Aphis.

Plate 1.

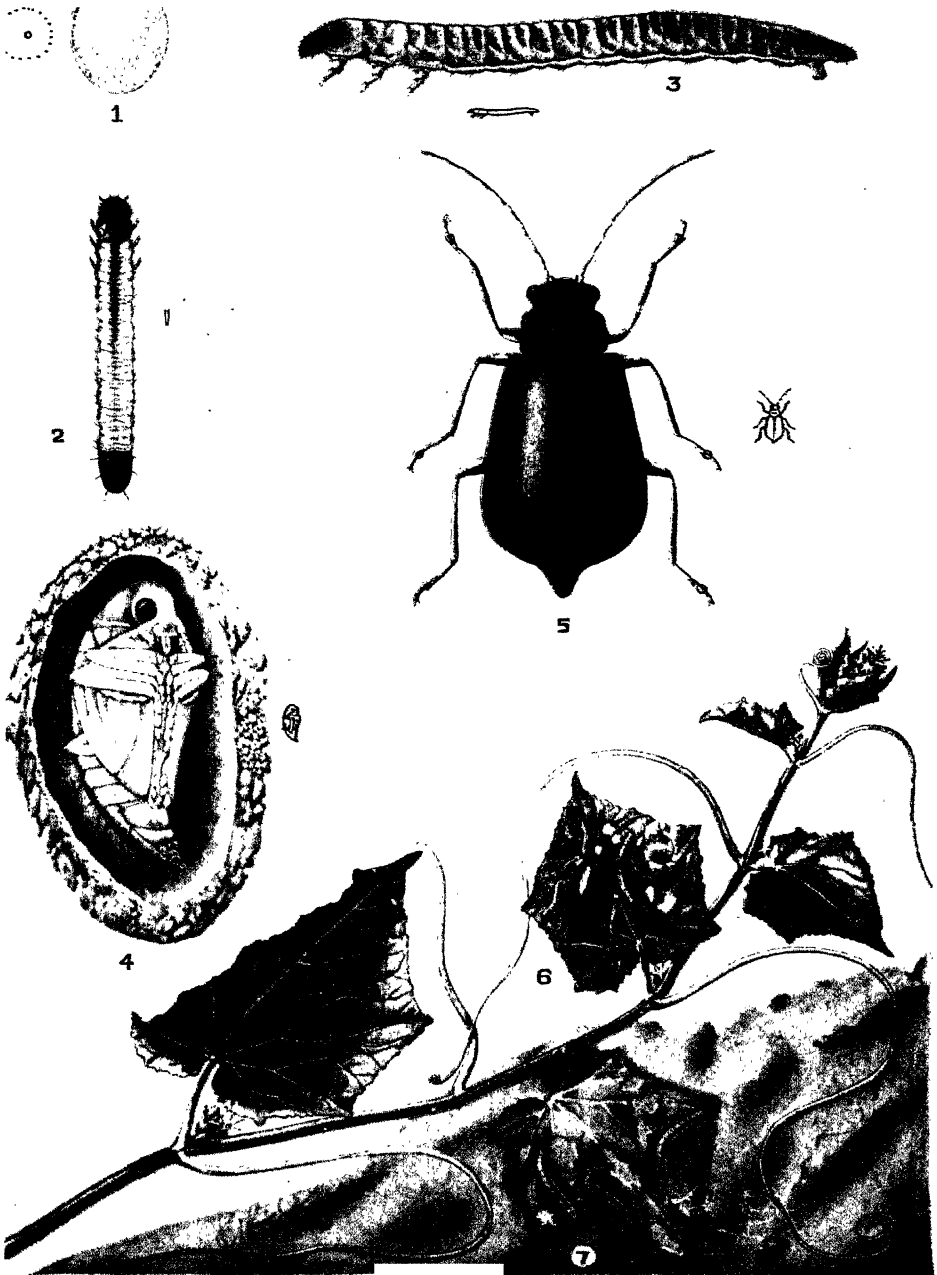
Aphis occasionally occurs but can be disposed of easily with a spray.

PLUME MOTH CATERPILLARS.

(*Sphenarches caffer*.)

Plate 36.

The small spiny caterpillar illustrated in Plate 36 occasionally occurs on the leaves of gourds. If few, they are best picked off but if a



Red Pumpkin Beetle
(*Aulacophora foveicollis*)

large number occurs, as may happen rarely, a spray with rosin compound is effective.

THE PUMPKIN BUG.

(*Aspongopus brunneus* Thunb.)



Text Fig. 62.

PUMPKIN BUG (*Aspongopus brunneus*).

These bugs occasionally prove very serious and rather disgusting on account of the buggy smell which fills the whole neighbourhood when the insects increase in number. Eggs are deposited on leaves and are joined end to end in long lines, and so are easily visible. The young bugs feed by sucking juice like the adults and gradually grow, casting off skins at intervals, developing wing pads and attaining the adult state when the wings are fully developed. Eggs take about nine or ten days to hatch and the nymphs take about 25 days to attain to the adult state. The adult bugs do not fly much and are somewhat gregarious in habit living with the nymphs. Therefore the infested plant soon gets covered with nymphs and adults and succumbs to the large drain of sap. Breeding takes place only once in the rainy season, the adults living through the year. The pest principally occurs on gourds and pumpkins. Portions of leaves containing eggs should be removed and buried underground or burnt. If nymphs have already hatched they should be shaken off into kerosenised water. Unless these measures are taken in time a very nauseating situation may follow with loss of the plant.

THE PUMPKIN STEM BORER BEETLE.

(*Apomecyna pertigera* Thom.)

Plate 70.

This longicorn beetle (Figs. 5 and 6) is rather sluggish in movement and feeds on leaves and shoots, but the greatest damage it does is by depositing eggs (Fig. 1) in holes gnawed in the stem. Grubs (Figs. 2 and 7) hatch from these eggs and bore inside the stem extensively reducing the internal tissue into frass. When full-grown they transform into pupae (Figs. 3 seen from front, 4 seen from back and 7 seen from side in the bored stem). Beetles develop from these pupae. As many grubs usually occur in a stem the infested plant soon withers and decays. The life-cycle occupies about five to six weeks, *viz.*, egg about 6 days, larva about $3\frac{1}{2}$ to 4 weeks and pupa about a week.

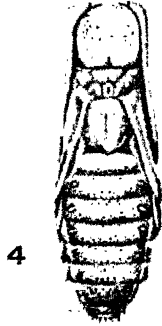
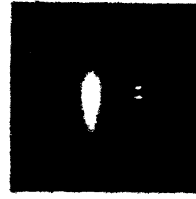
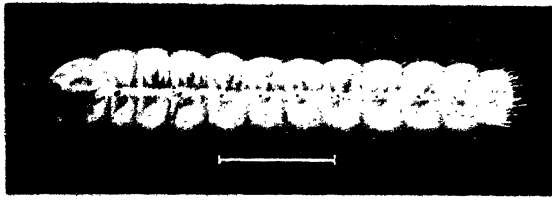
This pest occurs principally on gourds and pumpkins. The beetle should be looked for and destroyed. Badly infested plants are best uprooted and burnt in time so as to save other plants from being infested.

THE PUMPKIN LEAF ROLLER.

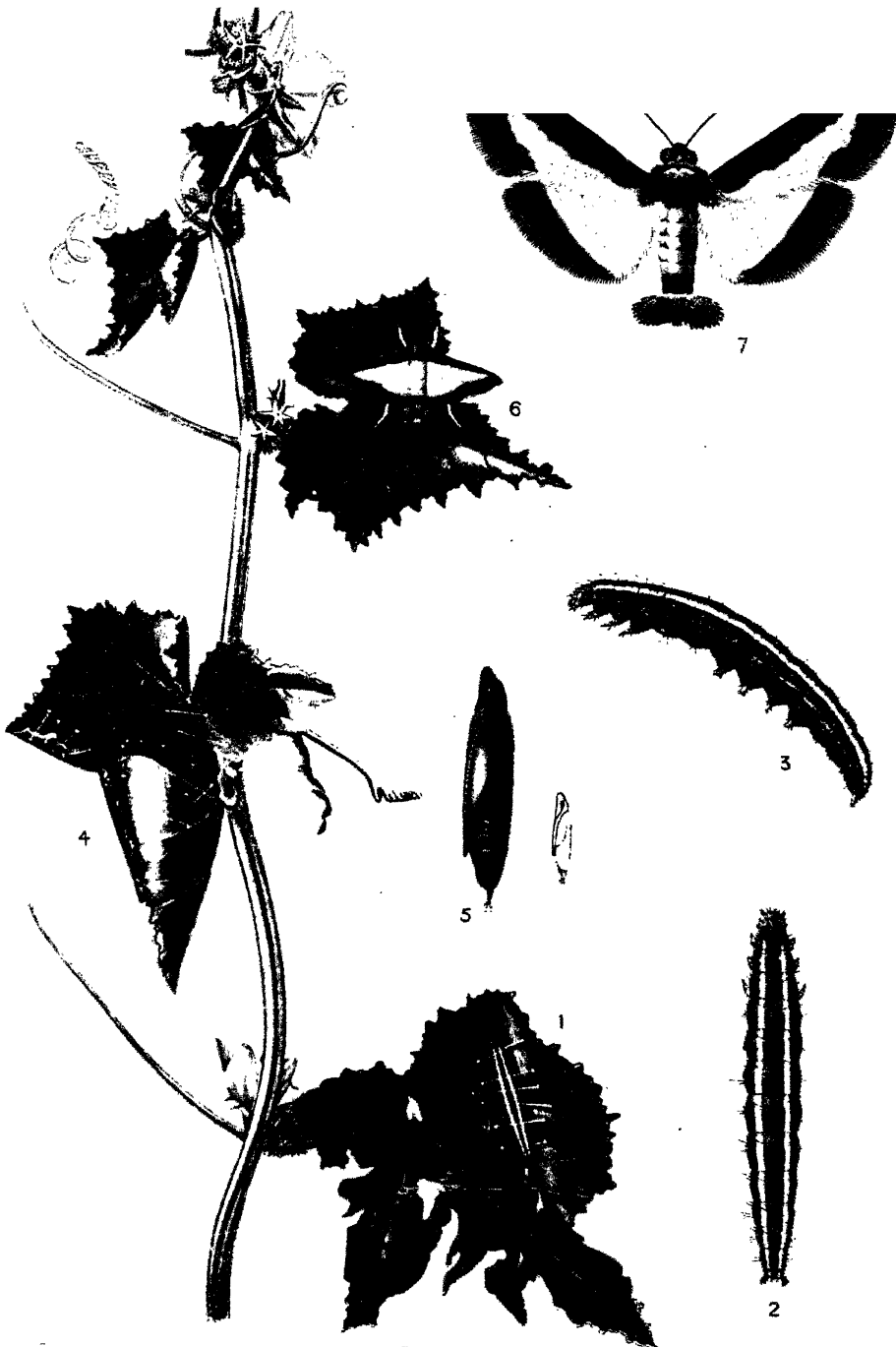
(*Margatonia indica* Saund.)

Plate 71.

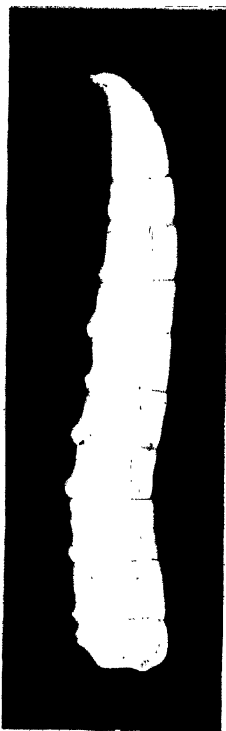
This green caterpillar with two prominent white stripes on the back (Figs. 1, 2 and 3) rolls and eats leaves, binding the roll with silk exuded from the mouth. When full-grown it transforms into a pupa (Fig. 5) inside the roll and the moth (Figs. 6 and 7) develops from the pupa.



Pumpkin Stem-borer Beetle
(*Apomecyna pertigera*)



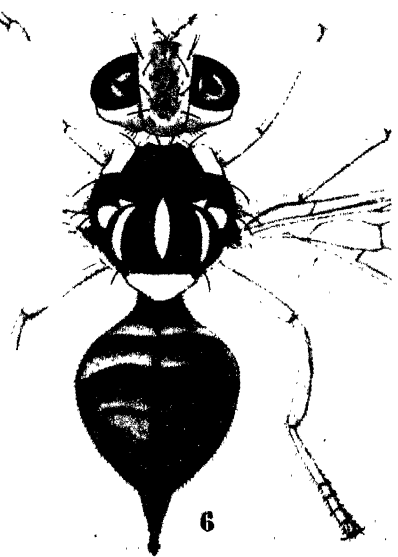
Pumpkin Leaf-roller
(*Margaronia indica*)



1

2

5



6

Fruit fly
(*Dacus cucurbitæ*)

The moth is a beautiful insect observed to fly about and deposit eggs on the plants during the day time. The leaf-rolling caterpillars hatch from these eggs. The life-cycle occupies about four weeks. The caterpillars can be got at simply by unrolling the rolled leaves and the moths can be caught in hand nets.

EPILACHNA BEETLES AND THEIR GRUBS.

(*Epilachna dodecastigma* and *Epilachna vigintioctopunctata*.)

Plate 67, Figs. 10 to 12.

The same 12 and 28-spotted beetles and their yellow spiny grubs, as have been illustrated on Plate 67 as pests of brinjal are bad pests occasionally occurring on these plants and destroying leaves in the same way.

THE GREEN SEMILOOPER.

(*Plusia agamma* Fb.)

Plate 34.

A green semilooper caterpillar as illustrated in Plate 34 under peas and beans occasionally occurs eating leaves. The life history is similar, but the moth is of dark grey colour.

FRUIT FLIES.

(*Chaetodacus cucurbitae* Loq.)

Plate 72.

These painted flies (Fig. 6 greatly enlarged about 8 times) are serious pests of fruits. Several eggs are thrust into fruits through wounds by the long ovipositor of the female fly. Maggots hatch out of these eggs and corrode the substance of the fruit causing it to rot (Fig. 1 maggots in infested fruit natural size; Fig. 2 one maggot much enlarged about 11 times). Cylindrical pale yellow flesh coloured wriggling maggots with the body tapering towards the head end are found inside infested fruits. As many maggots occur together hardly anything of the infested fruit is left. When full-grown the maggots in most cases leave the fruit and, going into the soil, turn into seed-like pupae (puparia). (Fig. 3 enlarged about 11 times.) Flies develop inside the puparia and issue by breaking open one end like a lid. The life-cycle occupies only about three weeks, viz., egg 2 to 3 days, larva about 14 days and pupa about 7 days. The flies live for two to three months and infest many fruits. In the absence of fruits fruit-fly maggots occasionally bore soft stems of young plants killing the plants.

Fruit-flies are rather difficult pests to deal with. There are many kinds of fruit-flies attacking many kinds of fruits, while again the same fly attacks several kinds of fruits.

Some fruit-flies are attracted to certain kinds of aromatic oil, such as citronella and can be captured in this manner, but the common fruit-flies cannot be dealt with in this way.

In common practice the best method of dealing with fruit-flies in gardens and plantations is to supply them with a sweet liquid food such as molasses water poisoned with an arsenical poison, such as lead arsenate, which they drink and die (see Mango Fruit-flies, page 166). It is necessary to keep a continuous supply of this poisoned food. This can be done by hanging a bundle of twigs under cover of a bent piece of tin and keeping the twigs wet with the poisoned mixture sprinkled on them (Text Fig. 63). It is necessary to hang several bundles here and there.



Text Fig. 63

FRUIT FLY POISON BAIT.

The other method is to collect and systematically destroy all infested fruits before the maggots leave them for pupation. The fruits should be thrown into deep water or buried underground at a depth of not less than three feet and the earth rammed down.

PESTS ON MISCELLANEOUS VEGETABLES AND CONDIMENTS.

On Sweet Potato.

The leaves are frequently attacked by the Common Hairy Caterpillar (Plate 32). Besides this, sweet potato has the following specific pests :—

TORTOISE BEETLES.

(*Aspidomorpha indica* Boh., *Metriana circumdata* Hbst, etc.)



Text Fig. 64.

LIFE-HISTORY OF A TORTOISE BEETLE (*Aspido-morpha miliaris*.)

1. GRUB, 2. PUPA, 3. BEETLE.

(1 AFTER MAULIK AND 2 AND 3 AFTER LEFROY.)

The beetles as well as their grubs feed by biting leaf tissue. Eggs are laid on the leaves. The grubs hatching from these eggs live, feed and pupate on the leaves and the beetles also live and feed on the leaves.

There are several species of tortoise beetles found on sweet potato and allied plants. The two noted above are taken as representatives. These beetles can be easily recognised from their shape which gives their common name. Their life history is practically alike. The beetles lay eggs in clusters, the eggs in the cluster being glued together into an egg case or ootheca. The grubs are flattened and spiny and have the peculiar habit of carrying their cast skins to which excrement is also added. The mass thus formed may be held behind or over the back. When full-grown the grub fixes its hind end on to the surface of the leaf and transforms into a pupa from which the beetle develops.

The life-cycle takes about four weeks, *viz.*, egg about four days, grub about twenty days and pupa five or six days. The beetles live up to about six months and each female lays up to about 500 eggs.

Although causing some damage to leaves the pests are seldom serious. If occurring in large numbers grubs succumb to a spray of rosin compound. The beetles require to be collected in hand nets or leaves on which they congregate can be plucked and placed in kerosenised water, as the beetles are rather sluggish in habit.

THE SWEET POTATO HAWK MOTH.

(*Herse convolvuli* Linn.)

Plate 73.

The caterpillars, with a horn at the hind end, green in early stages (Fig. 1) and grey, brown or earth-coloured when mature (Fig. 2) eat leaves and, being voracious eaters, cause great damage by defoliating the vines. When full-grown the caterpillar enters the soil, forms a sort of cell and transforms into a pupa (Figs. 3). The pupa is peculiar in having a loop-like case for the proboscis of the future moth outside the body. The moth (Figs. 4 in sitting and 5 in flying postures) develops from the pupa and lays globular pearly eggs on leaves and shoots. The caterpillars hatch from these eggs. The life-cycle in the hot weather takes about 35 to 45 days, *viz.*, egg about 4 days, larva about 15 to 21 days and pupa about 12 to 18 days. The pupa hibernates for several months in the cold weather and may also aestivate before emerging as a moth.

The caterpillars are easily visible and require to be picked off and destroyed.

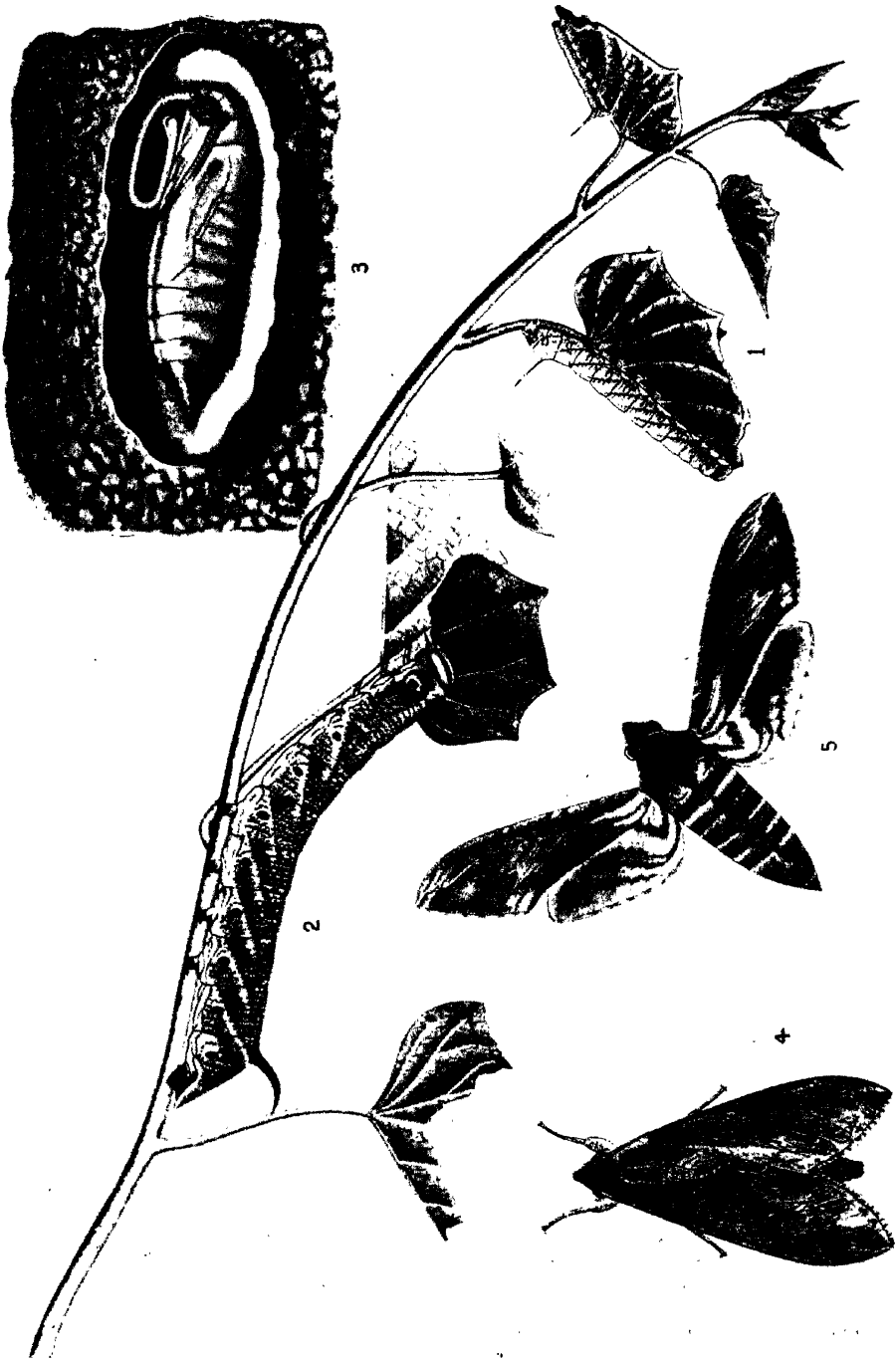
THE SWEET POTATO WEEVIL.

(*Cylas formicarius* Fb.)

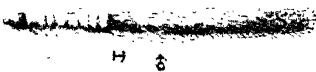
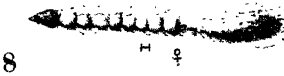
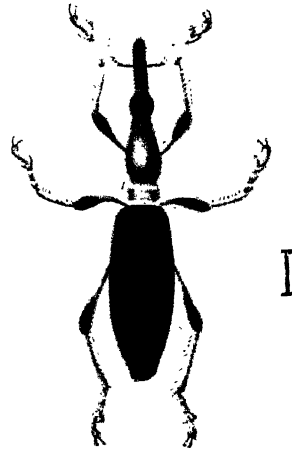
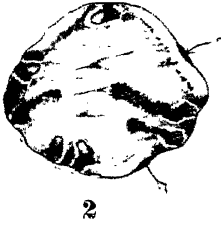
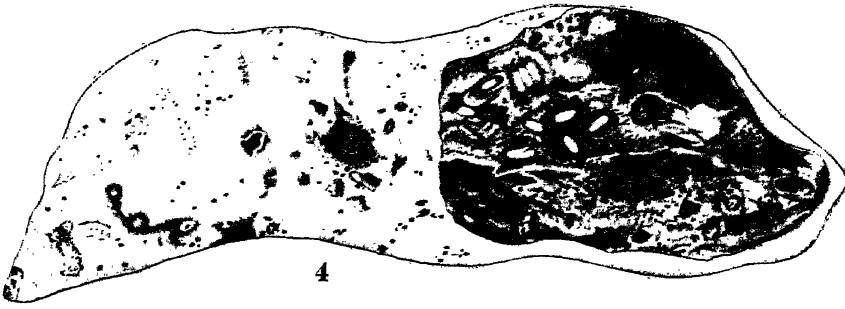
VERNACULAR AND LOCAL NAMES.—*Kazun-u-fo*, *Myauk-u-fo* (Tavoy).

Plate 74.

This is a serious pest of sweet potato tubers in which it breeds in large numbers riddling them and thus rendering them useless (Fig. 4 partly cut to expose the riddled interior). The adult weevil (Fig. 7) deposits eggs (Fig. 1) in holes gnawed with its snout into the tubers (Fig. 2 cut open to show how eggs are deposited). The grubs (Fig. 3) hatching from these eggs feed by riddling the interior of the tubers and when full-grown transform into pupae (Figs. 5 seen from back and 6 seen from the front) inside the tubers. Weevils develop from the pupae, issue out and feed by biting holes in leaves or gnawing into tubers. Breeding may also take place in stems but not on a large scale as in tubers. The life-cycle takes about 30 days, *viz.*, egg 4 days, larva



Sweet Potato Hawk Moth
(*Herse convolvuli*)



Sweet Potato Weevil
(*Cylas formicarius*)



Amaranthus Stem-borer
(*Lixus brachyrrhinus*)

20 days and pupa 6 days. The weevils are fairly long-lived and may live for about three to four months.

The pest occurs both in the field and store. Care should be taken to have the tubers as deep under the soil as possible and not to leave any exposed. Affected tubers should be cut into pieces, boiled and fed to cattle and should not be thrown out, as the weevil easily breeds in them.

ON TURMERIC, GINGER AND ARROW-ROOT.

There is no serious pest on these crops. Leaves are occasionally attacked by the Common Hairy Caterpillar (see Plate 32). Another leaf-rolling caterpillar (*Udaspes folus*) occasionally occurs which is hatched from egg laid by a butterfly and in its turn develops into a butterfly (Text Fig. 65).



Text Fig. 65.

BUTTERFLY OF TURMERIC LEAF ROLLER.

(*Udaspes folus*.) (AFTER SWINHÖE)

The leaves may also be attacked by thrips (see general pests) and the Plantain Lace-wing Bug (Text Fig. 85).

ON ONIONS.

Onions may suffer from thrips and aphids (See general pests).

ON AMARANTHUS.

Two leaf-binding caterpillars (*Hymenia fascialis* and *Eretmocera impactella*) occur on it, webbing leaves with silk and feeding inside the rolled leaves usually in large companies. Both are hatched from eggs laid by moths and develop into moths again. The bound leaves should be cut off and either buried underground or burnt.

THE AMARANTHUS STEM BORER.

(*Lixus brachyrrhinus* Boh.)

Plate 75.

A weevil grub (Fig. 3) bores the stem and causes swelling at the place bored (Figs. 1 and 2). When full-grown the grub transforms into

a pupa (Fig. 4) in the tunnel and ultimately developes into the weevil (Fig. 5) which gnaws holes in the stems with its snout and deposits eggs in these holes. Grubs hatch out of these eggs and cause the damage.

The pest is seldom serious but it is wise to take precautionary steps by cutting off affected plants and feeding to cattle either boiled or raw.

ON HORSE-RADISH TREE OR DRUMSTICK.

Hairy caterpillars with a similar life history to the Common Hairy Caterpillar (see Plate 32) are occasionally bad on leaves. When somewhat grown they drop down on shaking the tree and should be beaten or crushed to death.

The stem is occasionally bored by the large longicorn beetle grub which bores mango stems (Text Fig. 77) and can be treated in the same manner.

ON BETEL VINE.

White grubs (Plate 7) occasionally cut the roots thus killing the vines. These grubs usually find their way into the betel vineyards with cowdung manure. Before application the manure should be well sifted and searched for grubs. Raking up the soil and collecting the grubs may also be necessary.

The leaves and vines may be affected by mealy-wings and mealy bugs which have been described under general pests.

Two large bugs occasionally occur (*Cyclopelta siccifolia* and *Disphinctus politus*) which suck the plants' juice and require to be picked off. Their life history and habits are similar to those of the Green Bug (Plate 40).

ON WATER NUT.

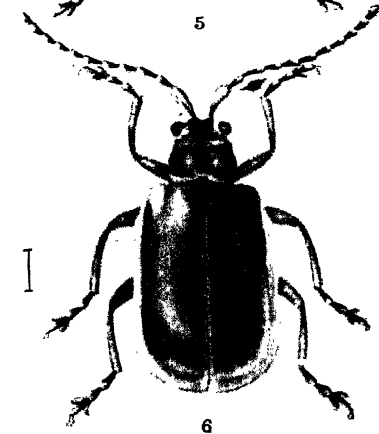
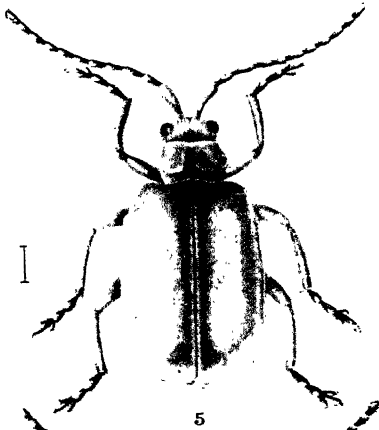
WATER NUT BEETLE.

(*Gallerucella birmanica*, Jac. *singhara* Lefroy.)

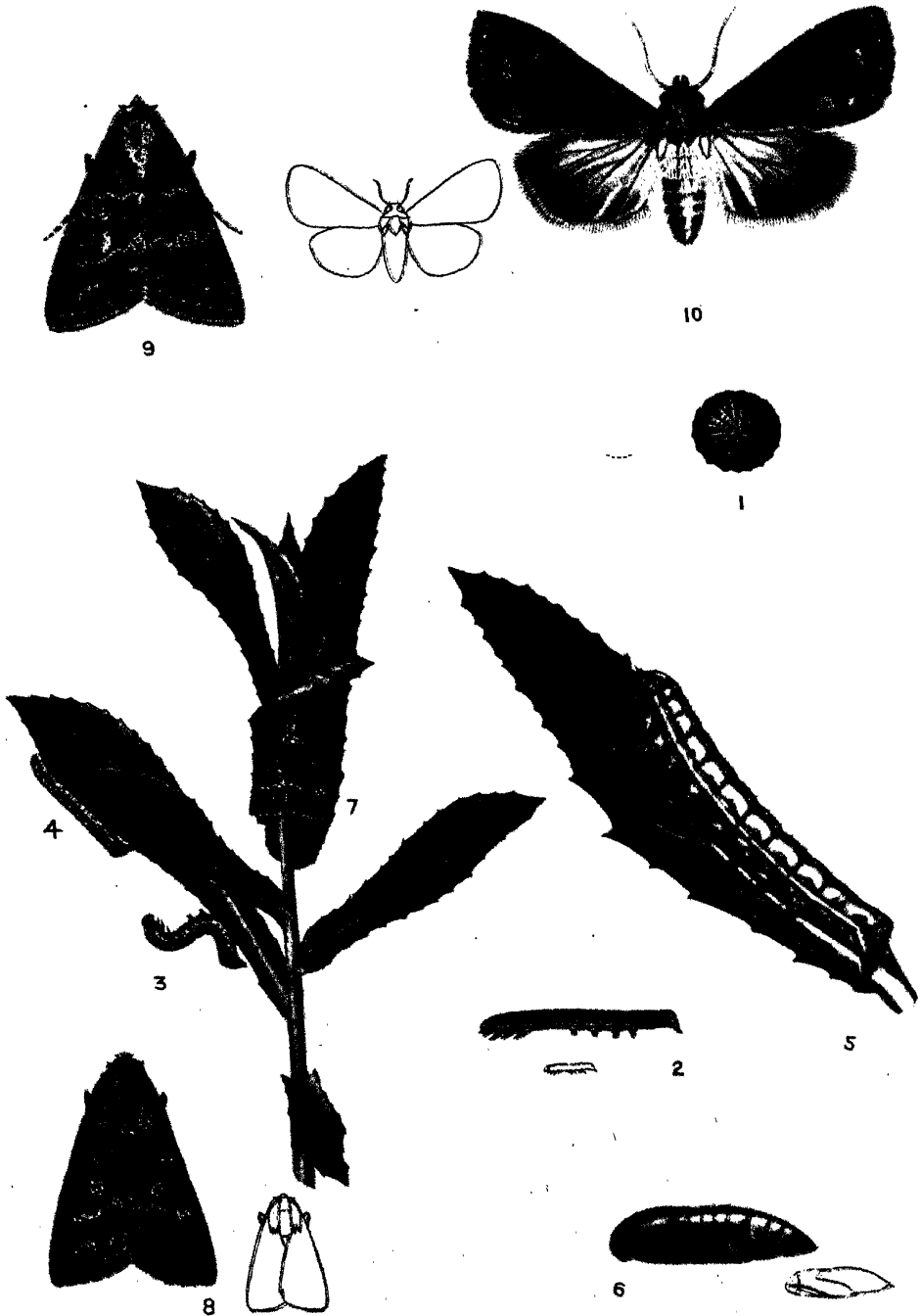
Plate 76.

The beetle (Figs. 5 and 6 enlarged) and its grubs (Fig. 3 enlarged) eat the leaves as shown in Fig. 1. The beetle lays round yellow eggs (Fig. 2 enlarged) in clusters on the leaves (Fig. 1). Grubs hatch from these eggs in about a week, feed and become full-grown in about three weeks when they transform into pupae (Fig. 4 enlarged) which are attached to the leaf by the hind end (Fig. 1). Adult beetles emerge in about a week more. The whole life history is passed on the leaves and the life-cycle takes about five to six weeks.

In case of bad infestation the leaves with eggs, grubs and pupae require to be collected and buried underground. The beetle can be caught in hand nets.



Waternut Beetle
(*Gallerucella singhara*)



Safflower Caterpillar
(*Perigea capensis*)

ON JERUSALEM ARTICHOKE.

Leaves are known to be attacked by the Common Hairy Caterpillar (Plate 32).

ON YAMS.

Hardly any insects are known to attack it.

ON ELEPHANT'S FOOT.

A large caterpillar of a hawk moth with similar life history to those of the Sesamum and Sweet Potato Hawk Moths (Plates 51 and 73) is known to eat leaves.

ON CORIANDER AND ANISEED.

Aphis occurs on them sometimes very severely but can be easily controlled by a single spray (see General Pests).

ON FENUGREEK.

Hardly any insects are known on it.

ON SAFFLOWER.

Safflower is grown mainly as a vegetable for its leaves. Aphis with a pinkish or dark reddish colour is a bad pest on safflower but is controllable with soap solution spray.

THE SAFFLOWER CATERPILLAR.

(*Perigea capensis* Gn.)

Plate 77.

This caterpillar (Figs. 2 to 5) is a persistent pest on safflower, eating the leaves, and is also known to occur on niger-seed, *artemisia*, and some wild plants. When full-grown (Fig. 5) it goes down into the earth and there transforms into a pupa (Fig. 6). The moth (Figs. 7 to 9 in sitting and 10 in flying posture) develops, emerges from the pupa and lays eggs (Fig. 1) on the plants at night. The caterpillars are hatched from these eggs. The life-cycle takes about 35 days, *viz.*, egg about 6 days, larva about 21 days and pupa about 8 days.

The caterpillars are easily seen and picked off.

SAFFLOWER FLY BORER.

(Trypaneidae.)

Text Fig. 66.

FRUIT FLY BORER OF SAFFLOWER STEM.

A fruit-fly maggot attacks and bores the top shoots of the grown plants, frequently causing the tops of stems to split. Further growth of the plants is stopped. Some of the maggots when full-grown drop on the ground and pupate there while some may pupate on the split stems. Flies develop and emerge from the puparia. The life-cycle takes about 30 days.

The attacked shoots should be cut off and burnt.

Safflower leaves may be occasionally attacked by the Tobacco Caterpillar (Text Fig. 59) and also the Linseed Caterpillar (Plate 58).

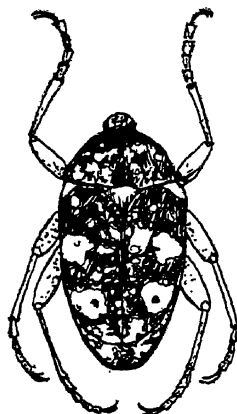
PESTS ON GARDEN PLANTS.

On Roses.



Text Fig. 67.

LEAF EATING BEETLE.

(*Adoretus* sp.)

Text Fig. 68.

LEAF EATING BEETLE.

(*Protætia fusca.*)

Beetles (*Adoretus* spp., Text Fig. 67 and *Protætia* sp., Text Fig. 68) bite holes in leaves at night and can be kept off by a repellent mixture sprayed on the leaves. The mixture may be kerosene emulsion which is however effective only as long as the smell of kerosene lasts or Bordeaux Mixture covering the leaves with a film of copper and lime.

The really serious pests on rose are scale insects occurring on stems and causing the plants to dry. The best thing is to spray with or wet the plants with swabs dipped in rosin compound solution. This is also effective against other injurious sucking insects like aphids, mealy bugs and mealy-wings and acts as a repellent to a certain extent against leaf-eating insects.

Termites (white ants) attack and kill roses in certain soils especially in dry seasons. Remedies are given under general pests.

On Balsam.

THE BALSAM HAWK MOTH.

(*Theretra oldenlandiæ* Fb.)

A large fat caterpillar with similar life history to the Sesamum and Sweet Potato Hawk Moths (Plates 51 and 73) eats leaves and defoliates the plants.

The caterpillars should be picked off and destroyed.

THE STEM-BORER WEEVIL.
(*Metialma balsaminæ* Mots.)



Text Fig. 69.

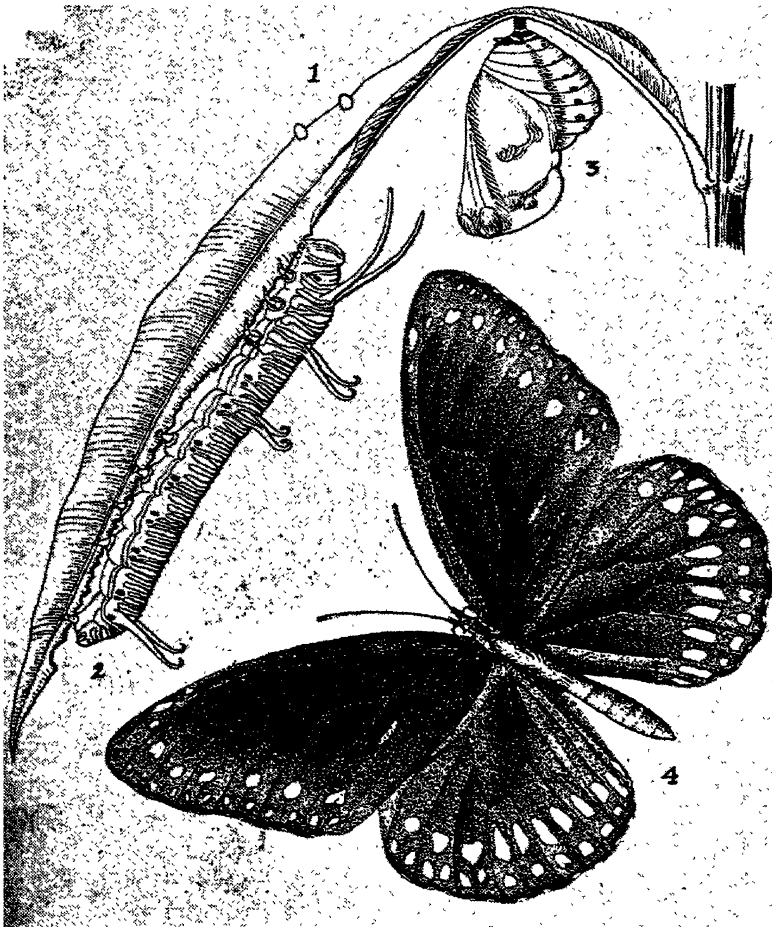
BALSAM STEM BORER WEEVIL (*Metialma balsaminæ*).

The grub of the weevil bores inside stems, pupates in especially-formed cocoons in the tunnels and ultimately issues as a weevil which deposits eggs in holes gnawed in the stems. Grubs hatch from these eggs. The life-cycle is completed in about three weeks.

Unless occurring in very large numbers the plants, though weakened do not seem to suffer seriously. The presence of the grubs is not easily detected and therefore hardly anything can be done. Withering plants should however be pulled out and either buried deep underground or burnt.

ON OLEANDER.

The Oleander Butterfly Caterpillar.
(*Euphœa core* Cr.)



Text Fig. 70.

OLEANDER BUTTERFLY.

1. EGGS, 2. CATERPILLAR, 3. CHRYSALIS, 4. BUTTERFLY.

This banded caterpillar with tentacles on its body eats leaves and when full-grown transforms into an oval seed-like pupa or chrysalis which is coloured with golden spots and hangs by a stalk. The butterfly emerges from this chrysalis and deposits eggs on the leaves from which the caterpillars hatch.

The life history and transformations can be easily observed if a few caterpillars are collected and fed with leaves in a large tumbler the mouth of which is closed by a piece of cloth tied over it.

The caterpillars if occurring in large numbers should be picked off. Eggs can be crushed. The butterfly can be caught in hand nets.

THE OLEANDER HAWK MOTH.

(*Deilephila nerii* Linn.)

A large fat caterpillar with similar life history to the Sesamum and Sweet Potato Hawk Moths (Plates 51 and 73) eats leaves. Ordinarily it completes its life-cycle in about a month, *viz.*, egg about 3 to 4 days, larva about 15 days and pupa about 9 days. It rarely occurs in numbers but being a voracious eater only a few can cause some damage. It is however easily seen and can be picked off and destroyed.

ON CHRYSANTHEMUM.

Aphis sometimes occur on it. Remedies are given under general pests.

ON LILIES.

THE LILY CATERPILLAR.

(*Polytela gloriosæ* Fb.)

Plate 78.

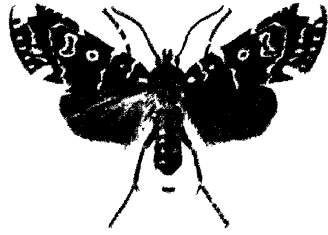
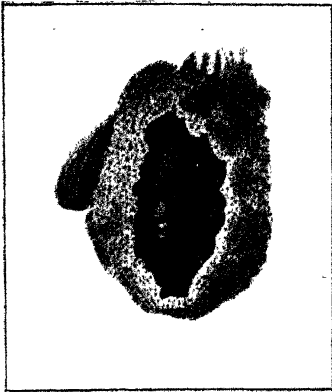
Lilies are eaten by a prominently-coloured caterpillar many of which occur together and eat away the plants. When full-grown the caterpillar goes down into the soil and transforms into a pupa in a specially prepared earthen cell whence it issues as a moth which lays yellow-coloured eggs in clusters on the leaves. The life-cycle ordinarily takes about four weeks, *viz.*, egg 3 to 4 days, caterpillar about 15 days and pupa 8 to 10 days. Pupae hibernate and aestivate from about November to June. Each female moth lays about 300 to 400 eggs. Unless controlled hordes of caterpillars are bred in the garden during the rainy season and no lilies may be left. Egg-clusters should be crushed between the fingers or bits of leaves bearing eggs nipped off and buried underground. The caterpillars should be picked off and placed in kerosenised water in a vessel. Moths can be captured with hand nets. It is necessary to destroy all caterpillars so as to prevent them from resting and appearing next year as moths to infest fresh lilies.

Brithys crini Fb. also occurs and its caterpillars and life history are very similar.

PESTS ON PLANTATION CROPS.

On Tea.

Tea is not a very important crop in Burma. Planters are advised to consult the literature on tea pests published by the Indian Tea Association and the United Planters Association, Southern India.



Lily Caterpillar
(*Polytela gloriosae*)

The two insects reported in Burma were both borer caterpillars at the roots, *viz.*, *Zeuzera coffea* and *Phasus malabaricus* of which the first appeared in some numbers. Control was effected by injecting carbon bisulphide into holes and at once stopping the holes with mud after injection.

Sucking insects, scales and mealy bugs when occurring can be controlled with spraying.

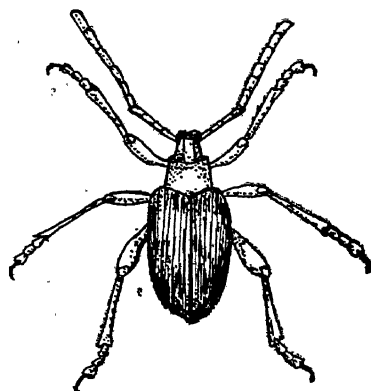
On Coffee.

Leaf-eating insects when they occur have to be controlled by collection. Scale insects are really serious and have to be sprayed.

On " *Thanat* " Pin (*Cordia myxa* Brandis).

The leaves of this tree are used as wrappers for cheroots used by Burmans. There are many grades but seven main ones are recognized. The best grade is produced by four of the Shan States, *viz.*, Mongpaw, Mongnai, Loikha and Mongsit. Two other states contribute to export, *viz.*, Hopong and Namkok but their produce does not equal that of the above in quality. The whole trade passes through Heho. In Mongpaw a substantial portion of the State's revenue is derived from a tax on individual trees, a tax which in its incidence seems negligible. The trees are kept in bush form and are pruned in January. Leaves appear in April and May, are plucked in July, carefully cured in local kilns and marketed in September and October (Report of Mr. A. McLean).

Insects are reported to damage the leaves and the damage is said to be at its worst about the end of June. It is not known what insects occur about this time. In September 1929 a few Spotted Grasshoppers (Text Fig. 51), a few weevils (Text Fig. 71) and a few Chrysomelid

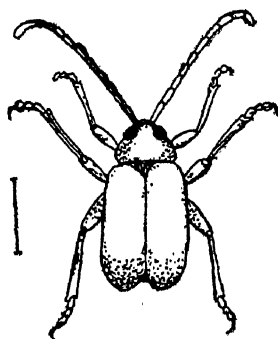


Text Fig. 71.

WEEVIL EATING *Thanatpin* LEAVES (*Cyphicerinus venosus*).

beetles (*Clytena* Sp.) were reported to have been collected from these trees at Mongpaw. Any insect biting holes in the leaves proves injurious. Large insects like the grasshopper and the Chrysomelid beetles are best collected with hand nets.

Fairly large black shiny grubs of a beetle (Text Fig. 72) occur on and eat the leaves, sometimes in fairly large numbers. The grubs when full-grown descend to the ground and pupate there in cocoons made with agglutinated earth. These grubs are gregarious and the few leaves on which they may be found should be plucked off with the grubs on them and buried underground. Affected leaves are easily visible on account of the black grubs and their black excreta.



Text Fig. 72.

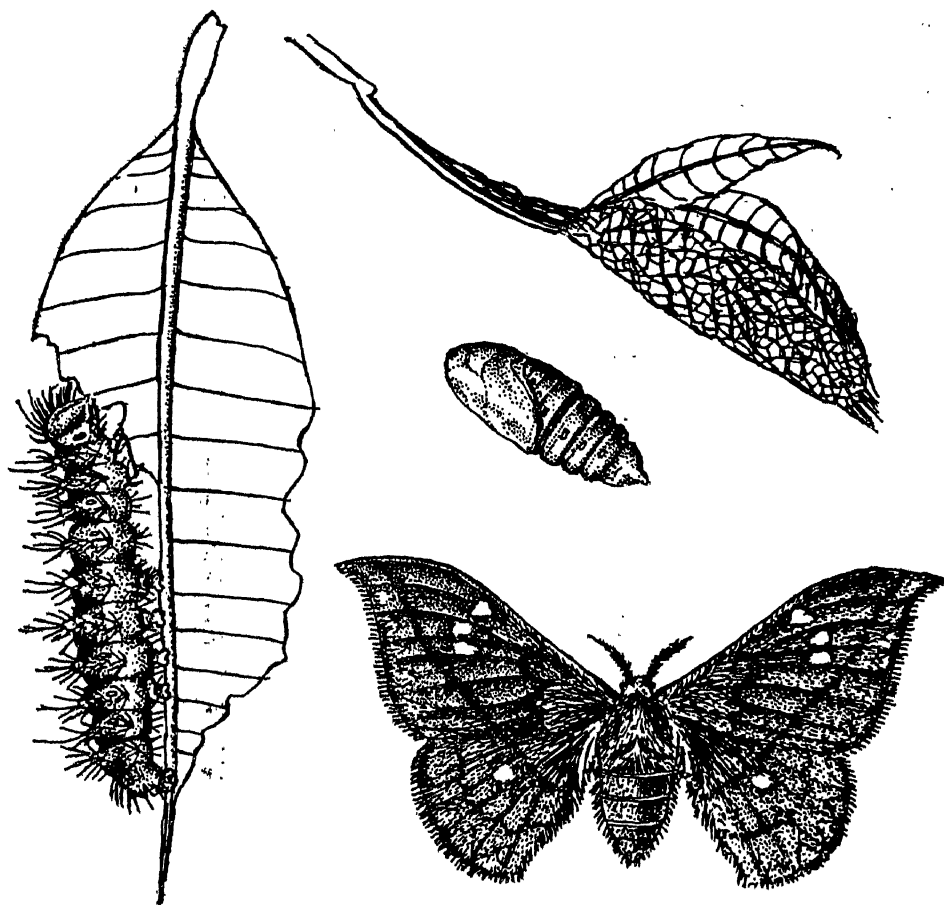
LEAF-EATING BEETLE ON *thanatpin*. (*Corynodes*).

PESTS ON FRUIT TREES.

The general pests on fruit trees are aphids, mealy-wing bugs and mites which occur on leaves and mealy bugs and scale insects which occur on leaves as well as on stems. Longicorn beetle grubs bore stems. Different beetles bore different trees and often cause serious damage. Leaf-eating caterpillars also occur. Fruits are damaged by beetles and fruit-fly maggots which bore and feed inside. Some fruits are sucked by a few large moths at night, the fruits being pierced with the proboscis for the purpose. These pests are mostly specific. The important ones are described below.

Several fruit trees hardly suffer from any insect pests. Such as wood-apple, jak, bael (*Ægle marmelos*), pine-apple, durian, mangosteen and tamarind although some insects occur on them.

ON MANGO.
THE MANGO HAIRY CATERPILLAR.
 (*Cricula trifenestrata* Helfer.)



Text Fig. 73.

MANGO HAIRY CATERPILLAR—CATERPILLAR, COCOON, PUPA AND MOTH.

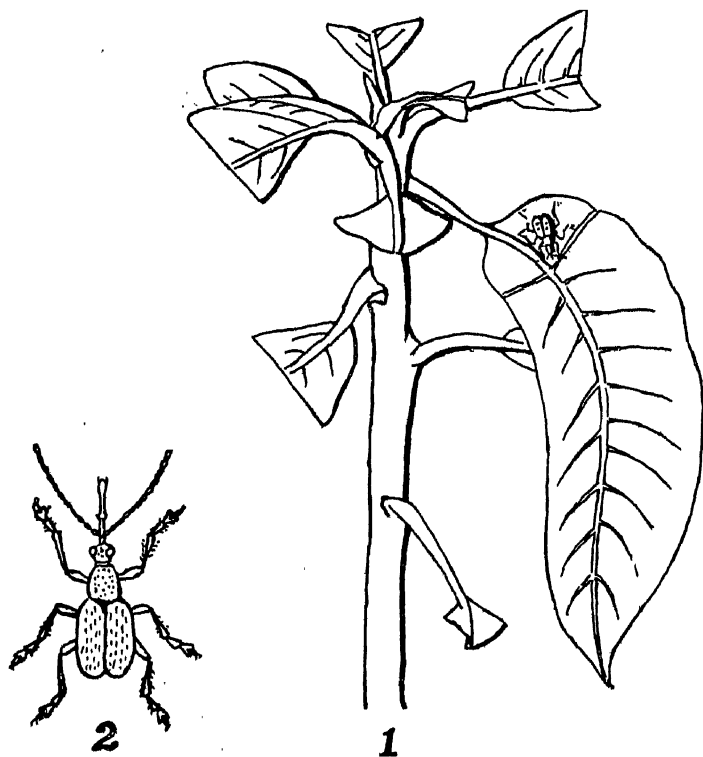
This large rather beautiful hairy caterpillar occurs in large companies and feeds gregariously on the leaves, in the worst cases almost wholly defoliating the trees. When full-grown the caterpillars form open-meshed silken cocoons in a mass among the leaves. The silk is of a golden colour. Pupation takes place inside the cocoon and the pupa is visible through its meshes. Fairly large moths emerge from the pupae and lay eggs in masses on the plant. The caterpillars hatch from these eggs. The life-cycle takes about two to three months, *viz.*, egg about 15 to 20 days, larva about 40 to 50 days, and pupa about 25

days. The hairs on the body of the caterpillars are urticating and may cause sores on the skin. These hairs get woven into the cocoons and for this reason the silk in the cocoons cannot be used although otherwise of fairly good quality. Neither the caterpillars nor the cocoons should be handled.

The easiest way of getting rid of the pest is to hold a lighted torch with a long handle below the caterpillars which drop down and should be buried underground. Twigs bearing masses of cocoons if formed, should be removed before moths emerge and should be similarly buried. The pest should not be allowed to increase. It also occurs on cashewnut trees.

THE MANGO LEAF CUTTING WEEVIL.

(*Eugnamptus marginatus* Pasc.)



Text Fig. 74.

MANGO LEAF CUTTING WEEVIL.

1. SHOOT WITH CUT LEAVES AND ONE WEEVIL CUTTING A LEAF, 2. WEEVIL ENLARGED.

This weevil appears when the trees put forth tender leaves and cuts across these leaves near their bases. All tender leaves may be cut off in this manner and the ground below strewn with them.

Eggs are inserted into the tissue of the cut leaves. The grubs which hatch from these eggs within about two or three days time, that is, feed on the tissue between the two surfaces of the leaves and become full-grown in about five or six days and enter into the ground. Some may emerge as adults in about 4 or 5 days more but the majority rest till the next season when they turn into pupæ and issue as adults.

Nothing can be done against the weevils. But if the cut and fallen tender leaves are systematically gathered every three days and burnt breeding can be stopped so that there may be no weevils next year. This practice must be followed every year systematically in order to be able to control the pest successfully.

MANGO BLOSSOM JASSIDS.

(*Idiocerus atkinsoni* Leth., *Idiocerus niveosparsus* Leth.,
Idiocerus clypealis Leth.)

VERNACULAR AND LOCAL NAMES.—*Hninga*, i.e., BITTER FROST OR DAMAGE
 CAUSED BY FROST; *Pada-sok-po*, i.e., MERCURY SUCKING INSECT
 (MINBU); *Po-sat-kaung* (KYAUKSÈ) *Pya*, *Pyada-po* (MAGWE)

Text Fig. 75 and Plate 22.



Text Fig. 75.

MANGO BLOSSOM JASSID—(AFTER LEFROY.)

If one approaches mango trees in blossom some small insects and in bad cases swarms of them jump out against the face. These hopping insects or jassid bugs suck the blossoms and at the same time breed on them. Eggs are inserted into the tender stalks of the blossom and also on the ribs of tender leaves and the young nymphs which hatch out of them feed by sucking the blossoms in the same way as the adults. They grow and develop wings gradually. Eggs hatch in about five days and the nymphs grow into adults in about ten days. The adults are however very long-lived and some of them live up to the next season. Breeding can also take place on tender tissues and such

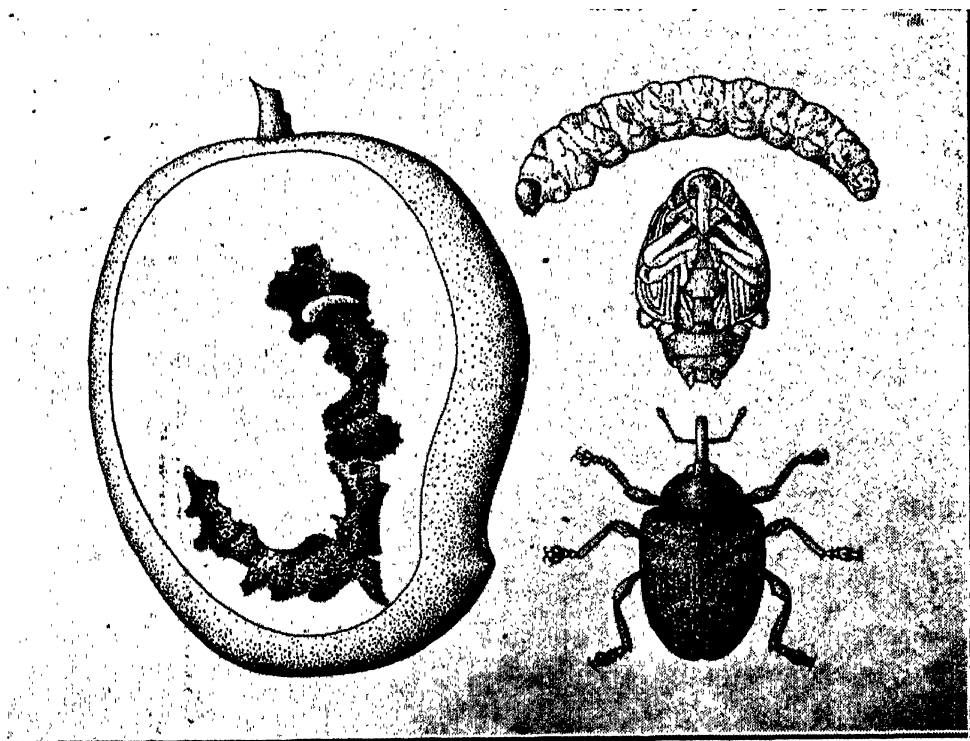
tissues are available in plenty in the blossoms and breeding therefore takes place on a large scale at this time. The trees may become covered with swarms of the bugs. As a consequence the blossoms fail to bear fruits. The bugs secrete a liquid which falls on leaves and blossoms below on which a sooty fungus develops giving a scorched appearance to the trees.

The jassids are a serious pest of mango and can only be controlled by spraying the trees thoroughly once just after the blossoming season commences and again about twice during the season with strong fish oil rosin or rosin compound solution or by dusting the blossoms thoroughly with sulphur. All the trees in the garden and the neighbourhood must be treated in order to obtain satisfactory results.

THE MANGO FRUIT WEEVILS.

(*Cryptorhynchus mangiferæ* Fb. and *C. gravis* Fb.)

VERNACULAR AND LOCAL NAMES.—*Athee-hpaukpo* (TAVOY), *Thayet-po* (AKYAB).



Text Fig. 76.

THE MANGO FRUIT BORER WEEVIL.

A FRUIT PARTLY CUT TO SHOW HOW THE PULP IS DAMAGED; GRUB ; PUPA ; WEEVIL.
(ALL MAGNIFIED ABOUT $3\frac{1}{2}$ TIMES.)

Both the weevils are injurious to fruits but in different ways. The grub of one bores the pulp of the fruit and as usually several grubs occur in a fruit it becomes useless. When full-grown the grubs leave the fruit and go into the ground where they turn into pupæ and soon attain the adult state. The adult weevils live in the ground or in crevices and other suitable hiding places on tree trunks till next year when they lay eggs on fruits again. The eggs are fixed on the fruits with a gummy substance. The grubs on hatching bore into the pulp directly. With the growth of the fruit the entrance holes get closed and are hardly visible. The affected fruits therefore hardly show any external symptoms.

The life-history of the other weevil is practically the same but the feeding habit of the grub is different. The young grub on hatching from the egg works its way at once into the stone of the fruit leaving hardly any trace of attack in the pulp which is therefore not damaged and can be used. The grub feeds on the seed leaves, pupates and attains the adult state inside the stone by the time the fruit ripens. The stone shows one or more holes according as one or more grubs have fed and developed in it, the weevils thus being ready to escape when it is thrown away.

The pulp-boring insect is of course more serious and renders all fruits practically useless in some places, especially in Eastern Bengal and Assam. Both the weevils occur in Burma but are not yet bad anywhere. Both are easily carried from country to country in the fruits.

Control is difficult in the case of both unless drastic steps are adopted. It is necessary to destroy all the fruits in the case of the pulp-boring one by throwing them into deep water and all the stones in the case of the other by fire for two or three seasons successively. The measures should embrace as wide a locality as possible and the degree of success will vary with the thoroughness with which the measures are carried out.

THE MANGO FRUIT-FLIES.

(*Dacus* spp.)

VERNACULAR AND LOCAL NAME.—*Thayet-thee-pyat-po* (AKYAB).

Plate 72.

Fruit-flies are a serious pest on the fruits. Their maggots feed on the pulp usually occurring in numbers in a ripe fruit which is rendered unfit for use. The worm-like maggots can be distinguished by their shape which is blunt and truncated at one end and tapering to a point at the other end and by their wriggling habits. When full-grown they

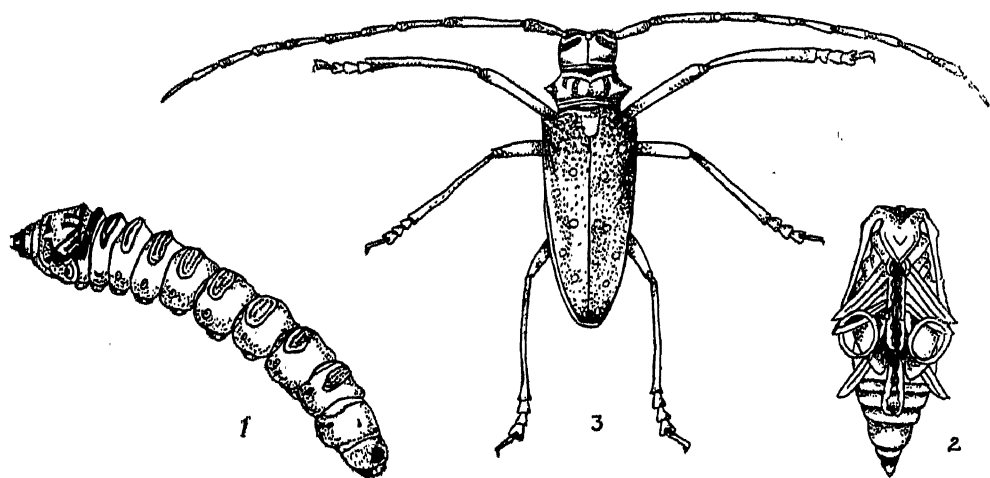
leave the fruits and enter the ground where they pupate and later issue as adult flies. The flies thrust eggs into the fruits and the maggots on hatching find themselves in the pulp on which they feed.

Fruit-flies are very difficult to control. The only means which gives some degree of success is to kill off the flies by supplying them with a poisoned attractive food before they lay eggs in the fruits. This is done by hanging bundles of sticks under cover of a bent piece of tin (Text Fig. 63) and keeping them moist with a spray made up of molasses water in which a poison, sodium arsenite or lead arsenate is mixed at the rate of about 2 ounces per gallon. Several such bundles are hung in different parts of a tree and the treatment commenced from the time when the fruits are about half-grown. In order not to help the pest to increase in number all affected fruits should also be destroyed by being thrown into deep water or buried below about three feet of soil which should be rammed down hard.

LONGICORN BORERS OF STEM.

(*Batocera rubus* Linn.)

VERNACULAR AND LOCAL NAMES—*Akaing-po* (AMHERST); *Akhet-hpauk-po*; *Pin-si-po*.



Text Fig. 77.

LONGICORN BORER OF MANGO STEM. (*Batocera rubus*.)

1. GRUB, 2. PUPA, 3. BEETLE.

Fairly large legless borers occur on mango trees boring long tunnels through branches and stems and throwing out dust through openings made here and there in the affected parts. The grubs feed in this

manner for about ten months and when full-grown transform into pupæ in the tunnel and then into adult beetles which bite their way out. The beetles have powerful jaws with which they gnaw slits in the bark of the trees and thrust eggs into the slits. The grubs on hatching from the eggs in about 10 to 12 days bore their way into the woody parts and form tunnels as described above. The life-cycle takes about eleven months. The beetles live for about three to four months.

The grubs of another beetle (*Rhytidodera robusta*—Text Fig. 78) bore the branches in the same way as, but occur in larger numbers than, the above. It is therefore more injurious.

It is not difficult to control these borers and save damage. This is done by injecting carbon bisulphide with an ordinary syringe through the holes emitting saw-dust and stopping all holes with mud. Attention should also be paid to orchard sanitation and all dead and dying branches should be sawn off and used up as fuel.



Text Fig 78.

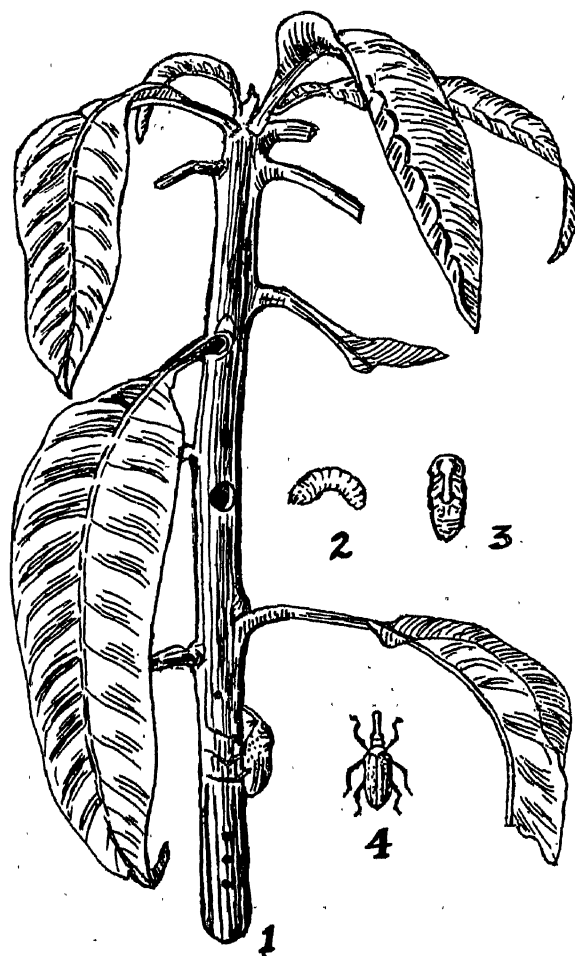
BEETLE BORERS OF TREE STEM.

1. *RHYTIDODERA*, 2—3. *ARISTOBIA* spp.

MINOR PESTS ON MANGO.

Several kinds of caterpillars occur on mango leaves but are not important. A weevil and a Chrysomelid beetle nibble holes in tender

leaves but are not bad as a rule.



Text Fig. 79.

MANGO SHOOT BORER WEEVIL. (*Alcides frenatus*.)

1. A BORED SHOOT SHOWING EXIT HOLE OF THE WEEVIL, 2. GRUB, 3. PUPA, 4. WEEVIL.

A caterpillar (*Chlumetia transversa*) and the grub of a weevil (*Alcides frenatus* Fst., Text Fig. 79) bore mango shoots but are seldom serious. It is better to cut off such twigs and burn them.

A tiny caterpillar mines just under the epidermal layer of the bark of new tender shoots, causing the layer to peel off. Hardly anything can be done against it. This no doubt retards growth but the shoots are seldom killed.

ON CITRUS.

All kinds of citrus trees, such as orange, lemon, lime, sweet and sour limes, shaddock, grape fruit, etc., suffer from various kinds of insect pests and require attention. It pays to give this attention.

Of the general pests scale insects and mealy bugs on stems and leaves and mealy-wings on leaves are frequently bad but can be easily controlled with spraying.

THE LEMON BUTTERFLY.

(*Papilio demoleus* Linn.)

Plate 4.

The life-history is given in a general way at page 11 and illustrated in Plate 4.

The caterpillars enjoy a wide range of food-plants. They have been found feeding on the following plants, viz.—Orange (*Lein-maw*); Sweet lime (*Shauk-cho*); Lemon (*Shauk-chin*); Sour lime (*Thanbya*); *Shauk-nu* or *Shauk-ka* (*Citrus hystrix*); Pomelo (*Shauk-pan* or *Kywegaw*); *Taw Shauk*; *Thanatka*; Wood-apple (*Thibin*); Bael (*Ok-shit*); *Ne-hle-bin* (*Psoralea corylifolia*) and *Ber* (*Zi-bin*).

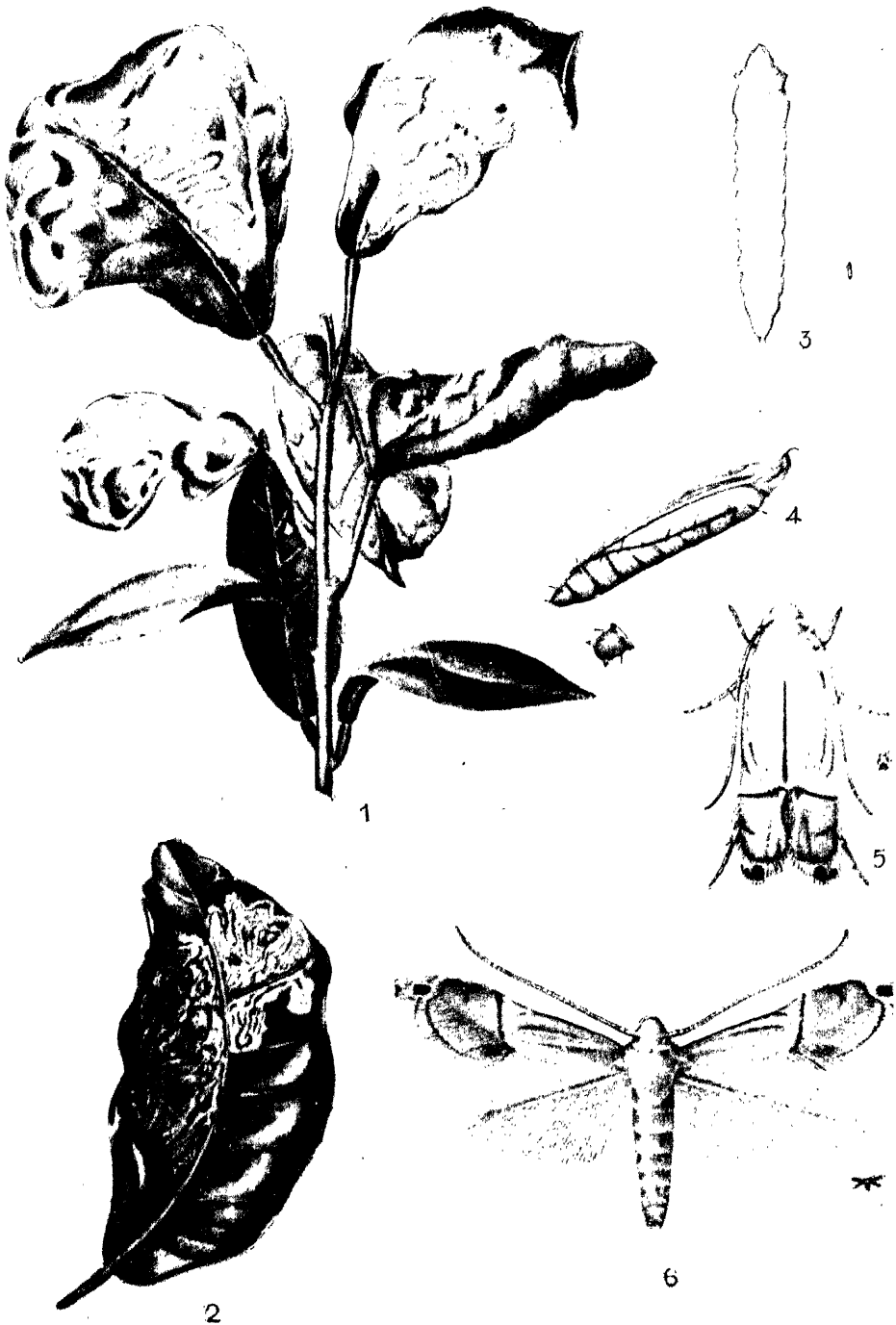
Seedlings and young trees may suffer badly from these caterpillars. This damage can be entirely prevented if the plants are regularly examined every three or four days. Eggs laid on the tender leaves and shoots are easily seen as pearly globules and can be rubbed off or crushed with the fingers. The young caterpillars, mostly sitting on the upper surfaces of leaves, are also easily visible. They should be regularly picked off. In a plantation the butterflies should be captured with hand nets.

THE CITRUS LEAF MINER.

(*Phyllocnistis citrella* Stt.)

Plate 79.

This tiny caterpillar (Fig. 3) mines just under the upper epidermis especially of tender leaves, producing zigzag streaks on the surface and causing the leaves to crumple. The entire upper surface of the leaf may be affected and in such cases the leaves suffer badly (Fig. 1). When full-grown the caterpillar rolls up a bit of the edge of the leaf forms a cocoon lining the roll (Fig. 2), pupates in the cocoon (Fig. 4)



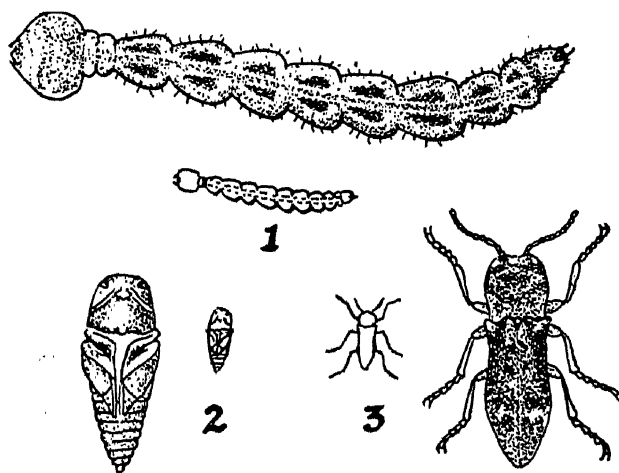
Citrus Leaf-miner
Phyllocnistis citrella

and ultimately emerges as the moth (Fig. 5 in sitting and 6 in flying postures). Moths lay eggs on the leaves and from these eggs the tiny caterpillars hatch. The life-cycle occupies about 15 to 20 days.

If one can undertake the trouble, rubbing the streaks with the fingers disposes of the caterpillars in them. This is possible in young plants. It is only the tender leaves which require attention. On grown-up trees the tender leaves require to be sprayed with strong rosin compound solution so as to have a layer of the solution on the surface. Spraying requires to be repeated several times when the trees put forth tender shoots.

THE CITRUS BARK BORER BEETLE.

(*Agrilus citri* Thery.)



Text Fig. 80.

CITRUS BARK BORER. (*Agrilus citri*.)

1. GRUB, 2. PUPA, 3. BEETLE.

Grubs of this beetle occur in large numbers on individual trees and bore extensively corroding both the bark and the underlying wood and filling the tunnels with dust-like frass. This corrosion acts like ring-barking and kills the tree or branches according as infection takes place in the main stem or higher up. When full-grown the grubs transform into pupæ in their tunnels and when the beetles develop from the pupæ they bore their way out producing round holes many of which are seen in the infected parts.

It is a new pest on citrus and new to science, previously unrecorded in India and Burma. It was first observed at Mandalay and proved to be of major importance.

Where this pest is observed to occur the first thing to be done is to saw off all infested branches and burn them. If any portion of bark shows symptoms of drying it should be cut open to see if any grubs are present and if present removal and burning of the dry or drying parts may help. Painting or white washing the stems with lime or Bordeaux Mixture affords a protection against the pest and may also effect a cure in the early stage of attack.

THE LONGICORN BORERS OF STEM.



Text Fig. 81.

LONGICORN BORERS OF CITRUS STEM.

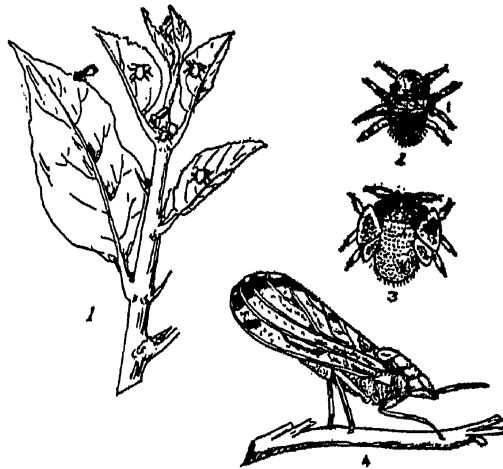
1. *MONOHAMMUS VERSTEEGI*, 2. *DIORTHUS SIMPLEX*.

Grubs of three longicorn beetles are known to bore stems and branches of citrus trees. They always bore the wood and throw

out dust through holes at different places in the affected parts. Their life-history is similar to that of the mango stem borer (Text Fig. 77) and they can be controlled in the same manner.

THE CITRUS PSYLLID BUG.

(*Euphalerus citri* Kuw.)



Text Fig. 82.

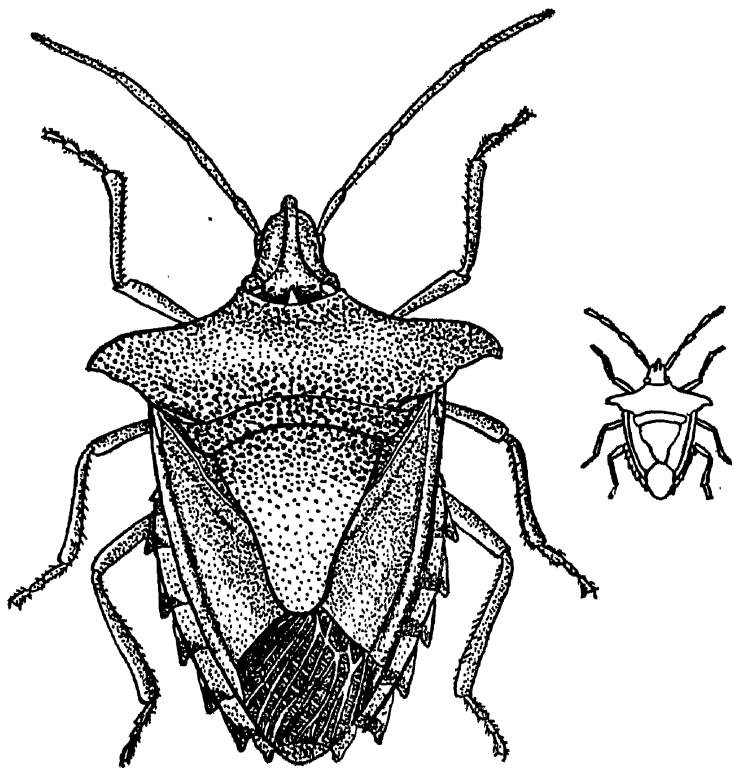
CITRUS PSYLLID.

1. NEW SHOOT ON WHICH THE INSECTS BREED AND FEED, 2. YOUNG NYMPH, 3. HALF GROWN NYMPH, 4. ADULT. (NATURAL SIZES ON THE TWIG.)

This little bug frequently occurs in numbers on tender shoots and leaves. Eggs are laid on these shoots and leaves and the nymphs sit gregariously and feed by sucking the sap like the adult bug. They gradually grow and develop wings attaining the adult state when the wings are fully developed.

Spraying with rosin compound solution is an effective cure.

THE ORANGE BUG.

(Rhynchocoris humeralis Thnb.)

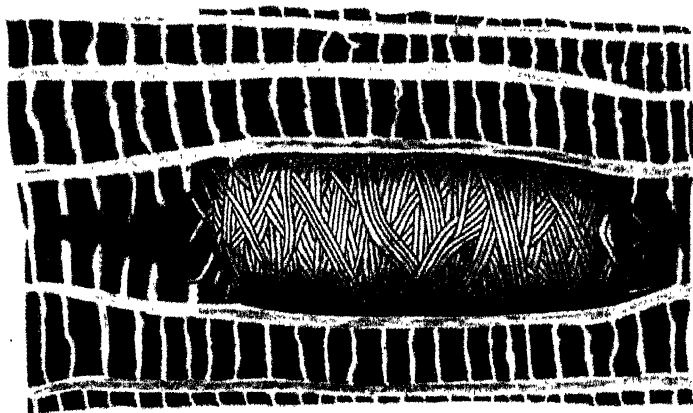
Text Fig. 83.

THE ORANGE BUG.

(Rhynchocoris humeralis.)

This fairly large bug appears when the trees begin to bear fruits. Their sucking causes many young fruits to drop off the tree. Eggs are laid on the trees and the nymphs also feed by sucking shoots and fruits. They cannot however fly until the wings are fully developed. Their life-history and development are similar to those of Green and Painted bugs illustrated on Plates 40 and 60.

The pest has not been studied well and hardly any effective measures can be suggested. In some places a flat bamboo winnowing fan is smeared with a very sticky plant juice, fixed on a pole and carried and swung among infested trees. The adult bugs flying out and striking the fans get stuck on them and are then destroyed.



4



On Guava.

Guava trees may suffer from scale insects and mealy bugs which can be easily controlled by spraying. Fruit-fly maggots sometimes occur in ripe fruits but are seldom serious.

On Pomegranate.

The leaves are occasionally eaten by the Castor Semilooper Caterpillar (Plate 53).

One serious borer pest of fruits present in India (*Virachola isocrates*), a butterfly, has not been met with in Burma and should be guarded against.

On Plantain.

Plantains do not suffer from many insect pests. Occasionally caterpillars bite leaves and a beetle nibbles holes in them. These are however not of importance.

THE STEM-BORER WEEVIL.

(*Odoiporus longicollis* Ol.)

VERNACULAR AND LOCAL NAMES.—*Gaung-fo*, i.e., head or corn borer (Kanbalu, Kawlin, Wuntho); *Run-fo* (Akyab—*Arakanese*.)

Plate 80.

This stem borer is probably the only pest of importance on plantains. The black weevil (Fig. 7) deposits eggs (Fig. 1) in holes gnawed in the stem. On hatching from the eggs the grubs (Figs. 2 and 3) bore up and down the stem. As usually many grubs occur in a stem it frequently breaks down (Text Fig. 84). When the grubs are full-grown they form cocoons (Figs. 4 and 5 shown separately removed from the stem) by twisting the fibres of the stem and transform into pupae (Fig. 6) inside the cocoon. The weevil develops from the pupa. The life-cycle occupies about two to four months according to season being longer in the cold weather. The adult weevils are long-lived and have been observed to live for about 90 days in confinement.

The pest although serious is usually confined to individual trees and is seldom widespread in a plantation. But it is worth while removing affected trees and killing off the insects present in them. The central core in fruiting trees is used as a vegetable. This should be an incentive to opening out the trees and when this is done the insects should be destroyed. Young trees when affected should be cut into pieces, boiled and fed to cattle.

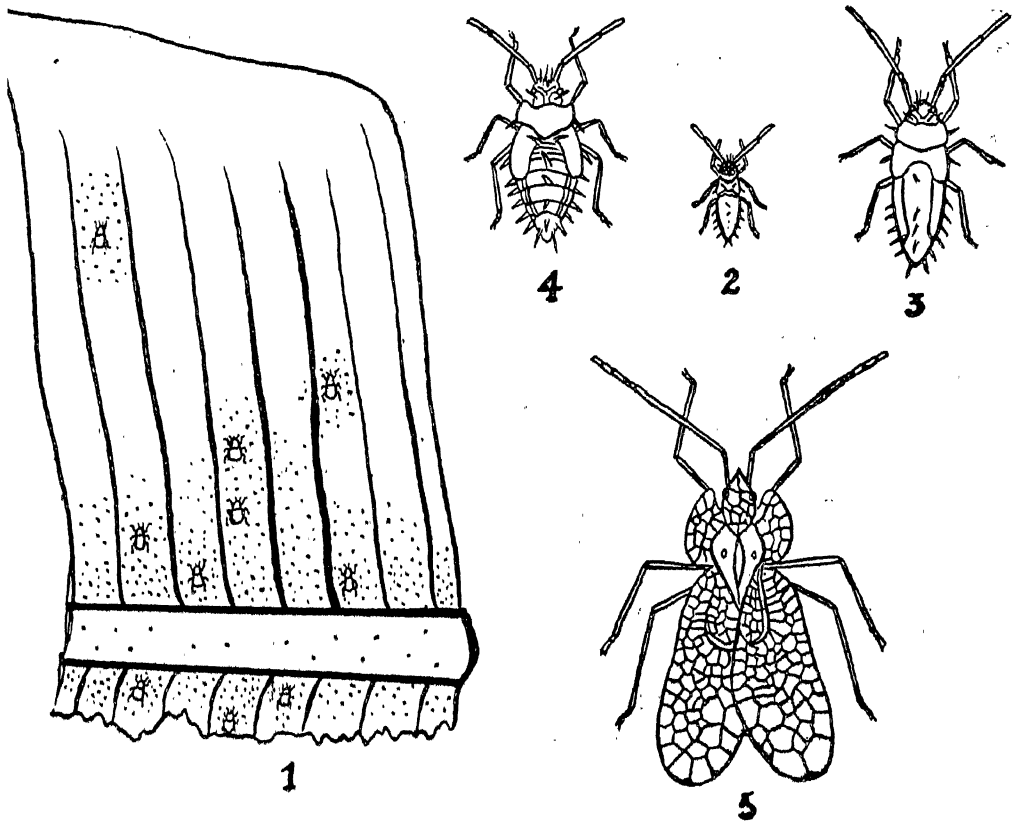


Text Fig. 84.

PLANTAIN TREE DAMAGED BY THE WEEVIL BORER.

There is an allied weevil (*Cosmopolites sordidus*) in other countries known to bore the root stocks of plantains and cause much more damage than the stem borer weevil and its entry into Burma should be guarded against.

THE PLANTAIN LACE-WING BUG.

(Stephanitis typicus Dist.)

Text Fig. 85.

LACE-WING BUG ON PLANTAIN. (*Stephanitis typicus*.)

(NATURAL SIZES ARE INDICATED BY OUTLINE FIGURES ON THE LEAF.)

1. THE INSECTS ON A BIT OF LEAF, 2—4. NYMPHS, 5. ADULT BUG.
 (AFTER PUSA BULL. 89.)

This lace-wing bug breeds on the under surfaces of leaves and large colonies containing nymphs in different stages of growth as well as adults are found gregariously on infested plants. The life-history is similar to that of the Potato Lace-wing Bug (Text Fig. 60). Eggs are laid on the leaves and the nymphs grow and develop wings like other bugs, attaining the adult state when the wings are fully developed.

The insect is of minor importance as a rule and if injuriously prevalent can be easily controlled by being sprayed with rosin compound solution.

On Mulberry.

Mulberry is of special importance on account of its leaves being used for rearing silk worms. It is grown for this purpose either as a bush or a tree which may be of medium or large size. It is allowed to become a tree when grown only for fruits. In different forms it suffers from different pests and in Burma different insect pests are observed to attack it in different localities.

THE MULBERRY THRIPS.

(*Pseudodendrothrips ornatissimus* Schmutz.)

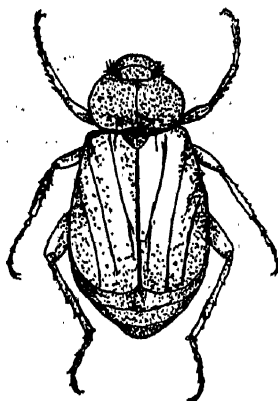
See Text Fig. 3 and page 8.

These minute thrips measuring about $\frac{1}{8}$ of an inch and yellow in colour is a serious pest of bush mulberry, especially young bushes, during the cold weather at Mandalay and is likely to prove so in other places in the plains. It multiplies enormously in a very short time and cold foggy spells of weather seem to help it. All new and tender leaves get covered by them and soon lose colour looking as if frost-bitten and later on falling off.

Whenever tender leaves begin to show symptoms of discolouration their lower surfaces should be examined for thrips which to a naked eye will appear like small yellow markings or streaks. If thrips are present all plants should be sprayed with weak rosin compound solution.

COCK-CHAFER BEETLES.

(*Lachnosterna* Sp.).



Text. Fig. 86.

MULBERRY LEAF-EATING COCK-CHAFER BEETLE.

(*Lachnosterna* SP.)

This chafer beetle swarms at night-fall after the first heavy showers of rain at the beginning of the hot weather and have been observed to cause serious damage to mulberry by eating leaves. The beetles prefer tall trees and tall branches and first attack the trees and then the tall shoots in a bush plantation and then gradually the dwarf bushes. They even seem to prefer chewing the bark of tall branches to coming down to low bushes. The low bushes however do not escape damage. The prevailing climatic conditions regulate their activities to a great extent. The damage is greatest in years with heavy showers of rain at intervals at the beginning of the hot weather. If there are light showers even though extending over the whole period the beetle does not emerge out in large swarms and there is very little damage as a consequence.

The grubs of this beetle are a serious pest of *pyaung* (Sorghum) in the neighbourhood of Mandalay. Its life-history is given under Sorghum at page 68. The beetle has so far been observed to behave as a pest of mulberry only at Mandalay.

It is necessary to be on the lookout for the beetles at nightfall after the first heavy showers of rain and they can be shaken off into vessels with kerosenised water. Almost all tall branches will be found covered with them. Kerosene emulsion spray may keep them off but its use is not possible when the leaves are required to be fed to silkworms.

THE MULBERRY LEAF ROLLER.

(*Glyphodes pyloalis* Wlk.)

A caterpillar allied to the Pumpkin Leaf Roller (Plate 71) and with practically similar life-history occasionally occurs on mulberry leaves but has not so far been observed to behave as a pest.

SCALE INSECTS.

See Plate 12.

Mulberry trees and medium trees frequently suffer badly from scale insects occurring on the stem and usually succumb to their attack if the insects are not controlled in time. The entire stem is usually covered by the insects which look like thin scales.

Control of the pests is not difficult and can be effected by two or three sprayings with strong rosin compound solution.

THE WHITE WAX MEALY BUG.

(Ceroplastes cereferus Anderson.)

Text Fig. 87.

WHITE WAX MEALY BUG ON MULBERRY.

(Ceroplastes cereferus.)

This large mealy bug with a large mass of white wax covering it frequently occurs on trees and medium trees and may cover them wholly with consequent loss of vigour and growth. Its general life-history is similar to that of mealy bugs described on page 44 under general pests.

The easiest method of control is to cut off and burn the twigs and branches on which the first bugs are noticed. This effectively prevents its increase. If spraying has to be resorted to, it requires a very heavy and vigorous spraying in order to be able to remove the large mass of wax covering the insects. Strong rosin compound solution has to be used.

Longicorn Borers in Stem.**Text Fig. 88.****LONGICORN BORER OF MULBERRY STEM—BORED STEM, GRUB AND BEETLE.**

Some varieties of tree mulberry suffer very badly from grubs of longicorn beetles in the hilly regions. More than one species of beetle seem to be concerned. One grub bores the wood just under the bark while another bores right in the centre of the stems and branches converting them into hollow tubes (Text Fig. 88). Both throw out lots of dust through holes communicating externally at different places in the affected parts.

Their life-history is similar to that of the Mango Stem Borer (Text Fig. 77). Control is effected similarly.

THE MOLE RAT OR BAMBOO RAT.

(*Cannomys castaneus* Blyth.)

VERNACULAR AND LOCAL NAME.—*Pway*.

See Text Fig. 30.

This burrowing rat which has been dealt with under general pests has been observed to be very fond of mulberry and frequently migrates into mulberry fields and plantations both in the hills and the plains and causes great damage by cutting across the roots and stems of bushes, grafts and young trees even two or three years old and killing them out-right.

They can be dug out and killed but it requires a lot of digging about the place before one is obtained. Trapping them with bamboo traps (Text Fig. 31) is the best and most inexpensive method.

On Tamarind.

It is a hardy plant scarcely requiring any attention. Longicorn borers occasionally occur in the stem (Text Fig. 77). The seeds in the fruits are infested to a very small extent by the seed bruchid (Text Fig. 96) an account of which is given at page 203.

On Papaya.

Hardly any insect occurs on it. The longicorn borers of mango stem (Text Fig. 77) may bore the stem but very rarely. Fruits occasionally suffer from fruit-fly maggots.

On Durian and Mangosteen.

Both are fairly resistant to insects. Occasionally longicorn borers (Text Fig. 77), occur in the stem and the leaves are affected by mining insects causing small or large blotches in the surface. They are hardly of much importance.

On Cashew Nut.

The leaves are known to be eaten by the Mango Hairy Caterpillar (Text Fig. 73).

On Custard Apple.

Scale insects and mealy bugs (Iac) may occur on the stem. The fruits are infested by white mealy bugs (*Pseudococcus virgalus*) which

make them very unsightly but can be easily controlled by being sprayed with rosin compound solution.

On Cherramoya.

The stem is occasionally bored by a longicorn borer (*Aristobia approximator* (Text Fig. 78). The same remarks and methods as under mango stem borer (page 167) are applicable.

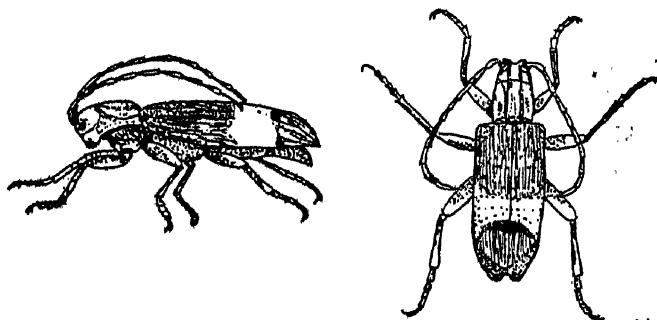
On Grape Vine.

Leaves are nibbled by a small Chrysomelid beetle (*Nodostoma subcostatum*) and also by cock-chaffer beetles at night. If the damage is bad they should be sprayed with a protective layer of Bordeaux Mixture. Dusting the leaves with flowers of sulphur or kerosenised dust is also effective. Leaves are also eaten by large hawk moth caterpillars (*Hippoteon celerio* and *Theretra alecto*) with similar life-history as that of the Sesamum and Sweet Potato Hawk Moths (Plates 51 and 73). The caterpillars are easily seen and can be picked off.

Sometimes leaves are rolled by a leaf rolling caterpillar (*Sylepta lunalis*) in the same way as the Cotton Leaf Roller to which it is allied (Plate 44). The leaves are better unrolled and the caterpillars destroyed.

THE STEM GIRDLER BEETLE.

(*Sthenias grisator* Fb.).



Text Fig. 89.

GRAPE VINE STEM GIRDLER BEETLE.

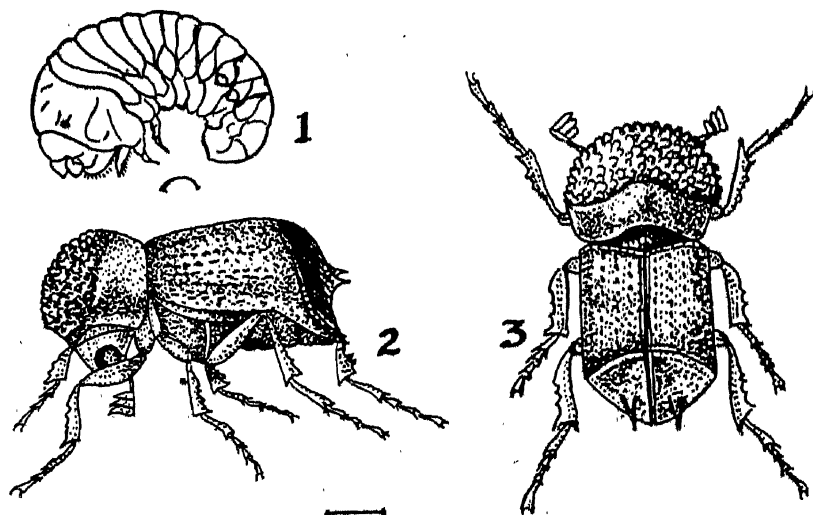
(*Sthenias grisator*.)

Occasionally this beetle possessing powerful jaws girdles the stem by biting a groove all round and causes the whole vine to wither. It is likely to cause severe damage in this manner. It is known to occur also on mulberry, roses, erythrina, oleander, drumstick tree, *Tabernaemontana*, *Bougainvillea*, etc., in India but has not been met with on mulberry or roses in Burma. It breeds by depositing eggs in the girdled and withering portion of the stem on which the grub feeds. Eggs hatch in about ten days, but grubs are known to feed for about four months to as long as about fourteen months. The life-cycle is therefore variable.

It is necessary to keep a careful look-out for the beetles which may be found sitting on the stems especially near withering shoots and leaves. They should be collected and destroyed. Hardly anything else can be done.

ROUND HEADED BEETLE BORER.

(*Sinoxylon anale* Lesne.)



Text Fig. 90.

ROUND-HEADED BEETLE BORER OF GRAPE VINE STEM.

(*Sinoxylon anale*.) (AFTER LEFROY AND PUSA BULL 89.)

Occasionally stems are bored by a small round-headed beetle and its grubs with a similar life-history to similar borers in bamboo and

wood (Text Figs. 100 and 103). The beetles breed in the stem, both grubs and beetles, thus causing damage. Their presence is indicated by emission of dust and frass.

If infestation takes place in twigs and branches they are better cut off and burnt. If however the main stem is affected the only plan would be to kill off the insects by covering the affected part with cotton wool soaked in carbon bisulphide and wrapping the cotton with a piece of oil cloth or rubber cloth in order to hold in the fumes. Treatment for about three hours would be sufficient.

ON PEACH, PEAR, PLUM, APPLE, SAPOTA, LOQUAT AND FIGS.

Leaf-eating caterpillars and beetles occur on them but are hardly of much importance.

Peach suffers from a serious pest in the form of fruit-flies the maggots of which bore the ripe fruits and render them useless. The same remarks and methods are applicable as given under mango fruit flies (page 166). Fruit flies may also occur on sapota, but rarely.

Figs may suffer from stem borers like the mango. The same remarks and methods are applicable as given under the mango stem borer (Text Fig. 77).

PESTS ON PALMS.

Coconut, betelnut and palmyra are the three palms of great economic importance in the province, the first two for their fruits and the third for the jaggery made from its juice. Date and nipa palms also occur but are of much less importance than the first named three. Although there are no large plantations of coconuts each village has or had until lately hundreds of coconut trees. Unfortunately this palm suffers most from insect pests and as a matter of fact is dying out on account of the ravages of these pests and will die out wholly unless vigorous and country-wide measures are adopted. Coconuts are now required to be imported in increasing numbers. It is possible to save the trees and to grow more of them if preventive measures are properly adopted. The same insects which occur on coconuts attack palmyra palms but to a much less extent. Betelnut, date and nipa palms hardly suffer from insects although some of the palm pests occasionally occur on them. The recently-introduced African oil palm is also subject to attack by the palm pests.

THE RHINOCEROS BEETLE.

(Oryctes rhinoceros Linn.)

VERNACULAR AND LOCAL NAMES.—*Kyanl-po*, i.e., rhinoceros like insect; *Nwa-chee-po*; *Ohn-po* or *Ohn-bo*; *Sin-bo*; i.e., elephant insect (Kanbalu, Wuntho).

Plate 81.

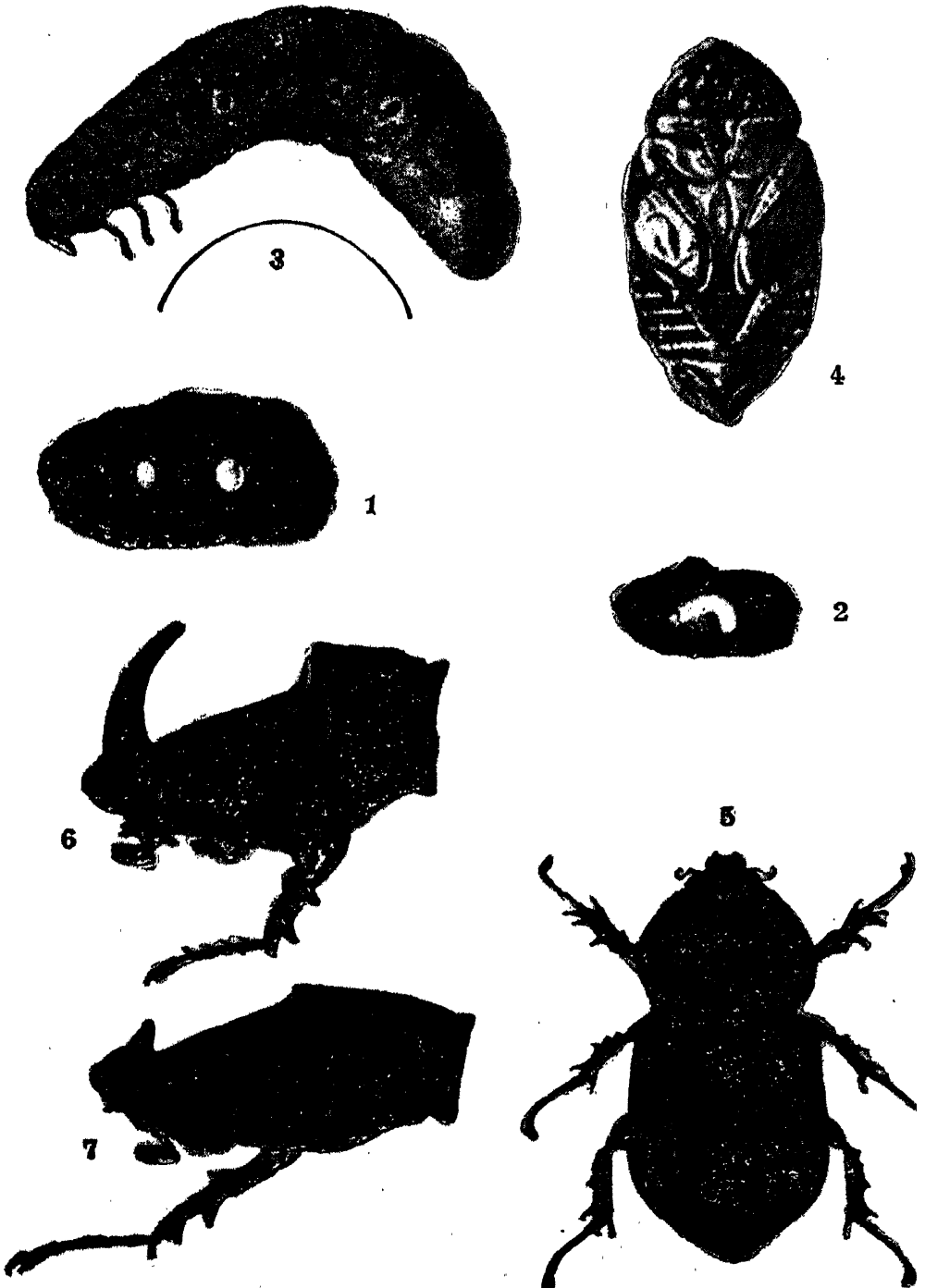
This is the most serious pest on coconuts and to a less extent on African Oil palm and then on palmyra palm and may occur occasionally on other palms.

The beetle (Fig. 5) itself does the damage. It flies at night and bores the tops of the trees. Several beetles occur on a tree at a time or one after another and the trees succumb to repeated attacks. Water lodges in the holes bored and sets up rotting which hastens the death of the trees.

The beetle breeds in dung heaps and any masses of rotting vegetable matter. Eggs (Fig. 1) are laid in such places. The grubs on hatching (Fig. 2) from these eggs feed on the rotting dung, straw and palm stems and when full-grown (Fig. 3) transform into pupae (Fig. 4) in specially prepared pupal cells and the beetles develop from the pupae. The life-cycle takes about four to six months according to season, being shorter in hot and longer in cold weather. Eggs hatch in 10 to 17 days, grubs feed for about 3 to 4½ months and the pupa takes about 16 to 25 days. The beetles live for about six months and are therefore able to bore and damage many trees during their life. Each female probably lays several hundred eggs in the course of her long life.

The principal breeding places are dung and rubbish heaps, dead stems of palms and wet rotting straw both in large and small heaps. The principal breeding season is the wet months of the year and up to about December. Hundreds of grubs are found in each dung and rotting straw heap and in dead tops and stems and inside stumps of cut palms, the rotting pith and bark of which seem to help the grubs to flourish. It is these breeding places which help the beetle to multiply and increase in number and thus to be able to cause the enormous damage which is noticeable everywhere.

A coconut tree growing healthily on the average fetches an income of about ten rupees a year. The owners therefore in some places in their anxiety to save the trees often pay as much as four annas for each



THE RHINOCEROS BEETLE OR THE BLACK BEETLE OF PALMS.
(*Oryctes rhinoceros* Linn.)

beetle extracted out of their trees. Extraction and destruction of the beetles in this manner hardly help when in place of one destroyed, probably a hundred are enabled by the same owner to breed out of the breeding places in his own compound.

The only effective measure is to look after the breeding places. It is not necessary to touch the trees. If the breeding of the pest is checked the trees revive of themselves. This was actually demonstrated by this department in Pyinmana and its neighbourhood which had about 30,000 coconut trees. A temporary fieldman was engaged to go about turning dung and rotting straw heaps and destroying the grubs and cutting down and destroying dead coconut stems. The municipal authorities carted and threw these stems into the neighbouring streams (*Ngalaik choung*) where they got buried under sand. In the course of about two years all the trees threw off their ragged appearance, assumed a bushy healthy crown and began to bear fruit. This work was not continued by the people when the fieldman was removed and the trees again deteriorated. Cheduba island is another instance of how the pest is enabled to increase in number and assume a serious attitude when it finds abundant breeding places. Here on account of washing by tidal waves dung and rubbish heaps are not of much importance. Two cyclones however killed many coconut trees and the beetle took the opportunity of breeding in the dead stems and, increasing in number, soon attracted attention on account of the damage it caused to living trees. Removal of the dead coconut stems is already showing a good effect. The effective measures against this pest are the following. They are not difficult or costly but requires to be enforced and adopted all over the province or over as large areas as possible.

1. Dung and rubbish heaps should be turned with a spade once every two months and the grubs, pupae and beetles present in them should be cut or crushed. The grubs can be collected and kept in an earthen pot or fed to fowls or thrown on dry hard ground or into deep water.

2. All dead palm stems should be removed and either split into pieces, dried and used as fuel or buried deep underground or under sand or thrown into deep water. If the stumps of the trees are left in the ground their pith harbours hundreds of grubs. Either they should be uprooted or their mouths filled with a layer of five or six inches of sand after first of all a search for grubs.

3. Straw heaps are better placed on raised platform or on high ground where there is no possibility of water soaking in at the bottom. The top of the heap should be made so that no water may soak in and

set up rotting. All rotting straw including rotting thatch should be searched for grubs like dung heaps.

4. The beetles are attracted to fermenting oil cakes which can be kept in water in an open-mouthed vessel.

The first three measures are essential and unless enforced by law are hardly likely to be adopted by all people. Such a law is necessary if coconut trees are to be grown in the province.

THE RED WEEVIL.

(Rhynchophorus ferrugineus Oliv.)

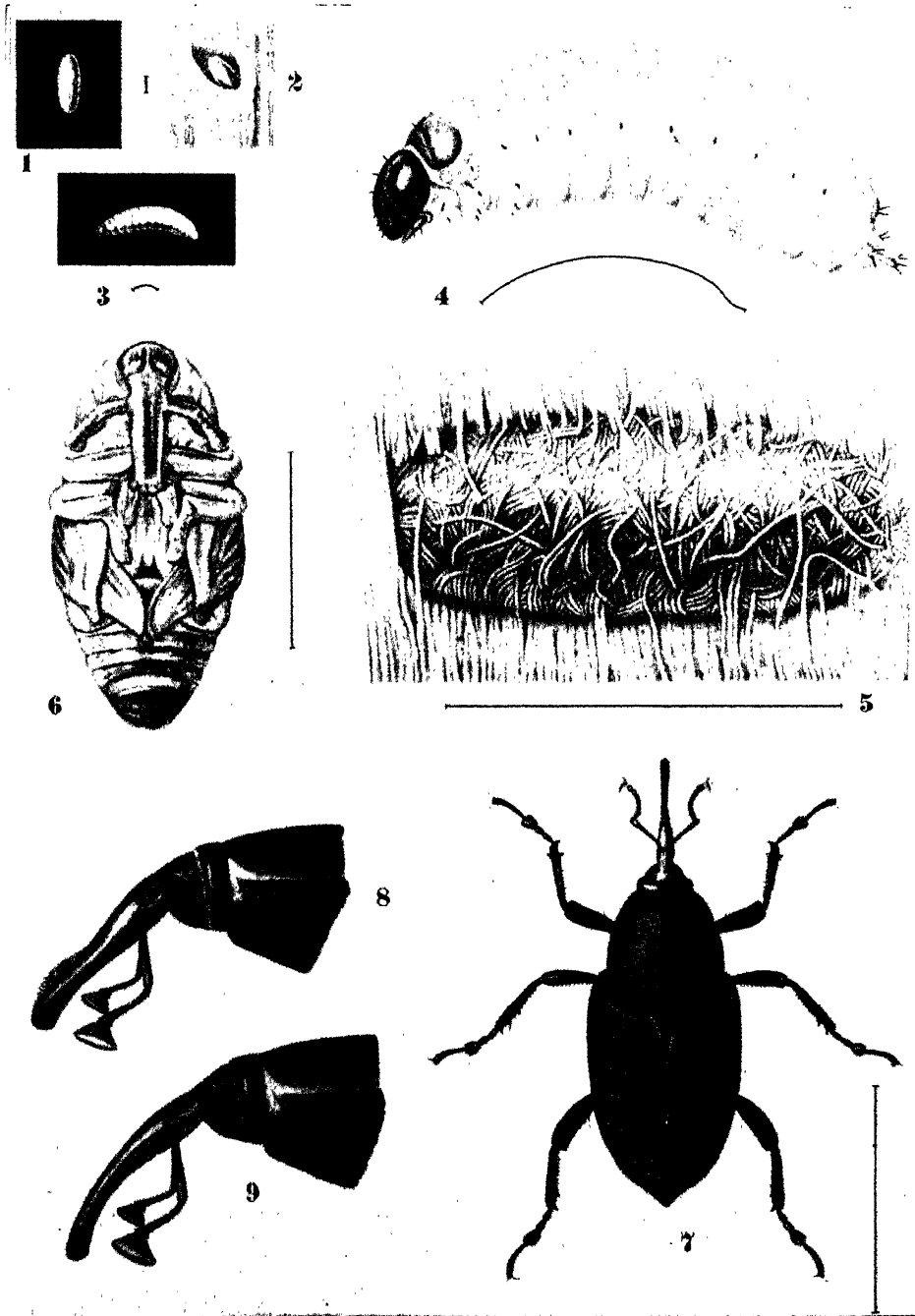
VERNACULAR AND LOCAL NAME.—*Ohn-bo* or *Ohn-pho*.

Plate 82.

The Red Weevil (Fig. 7, some having black patches and markings on the back not shown in the illustration) is a serious pest and may occur on all kinds of palms. The weevil itself, unlike the Rhinoceros Beetle, hardly causes any damage by feeding but lays eggs (Figs. 1 and 2) in living palm stems and the grubs hatching out of these eggs (Fig. 3) bore the stems thus killing the tree. Attack is usually confined to individual trees which harbour many grubs and are doomed. The grub when full-grown (Fig. 4) spins a cocoon (Fig. 5) with the fibres of the tree and transforms into a pupa (Fig. 6) in the cocoon. The weevil (Fig. 7; Fig. 8 head of male and Fig. 9 head of female) develops from the pupa, emerges from the cocoon and flies to and infests other trees. The holes bored by the Rhinoceros Beetle are frequently taken advantage of by this weevil which thus easily gets access to fresh tissue on which to feed as well as to deposit eggs.

The life-cycle occupies about 2 to 5½ months according to season. Eggs hatch in about 3 to 4 days. Grubs feed for about 1 to 3½ months. The pupa takes about 17 to 50 days. The adult weevil lives for about two months and each female lays about 300 eggs in the course of her life.

As soon as infestation is noticed the safest plan is to cut down and burn the infested tree, thus removing a source of damage to other trees, as many weevils develop from a single infested tree. The grubs are very much liked as food and are sometimes fattened by being placed inside coconuts on the kernel of which they feed.



The Red Weevil
(*Rhynchophorus ferrugineus*)

THE ELEPHANT BEETLE.

(Xylotrupes gideon L.)

Text Fig. 91.

THE ELEPHANT BEETLE.

1. EGGS, 2. GRUB, 3. FEMALE BEETLE, 4-5. MALE BEETLES.

This beetle, the male bearing long tusk-like appendages like pincers, breeds and feeds in the same way as the Rhinoceros Beetle but occurs in much smaller number and is much less injurious. It confines its ravages more to leaves but occasionally bores the stem. The grubs resemble, and occur in the breeding places with those of the Rhinoceros Beetle.

The measures recommended against the Rhinoceros Beetle successfully control this pest.

The beetles sometimes occur on lady's finger and eat the pods and require to be collected with hand and destroyed.

THE LEAF NIBBLING CATERPILLAR.

(*Nephantis serinopa*, Meyr.)

VERNACULAR AND LOCAL NAMES.—*Cha-byan*, *cha-pyan*, *cha-pyan-fo*,
i.e., flying termites.

Plate 83.

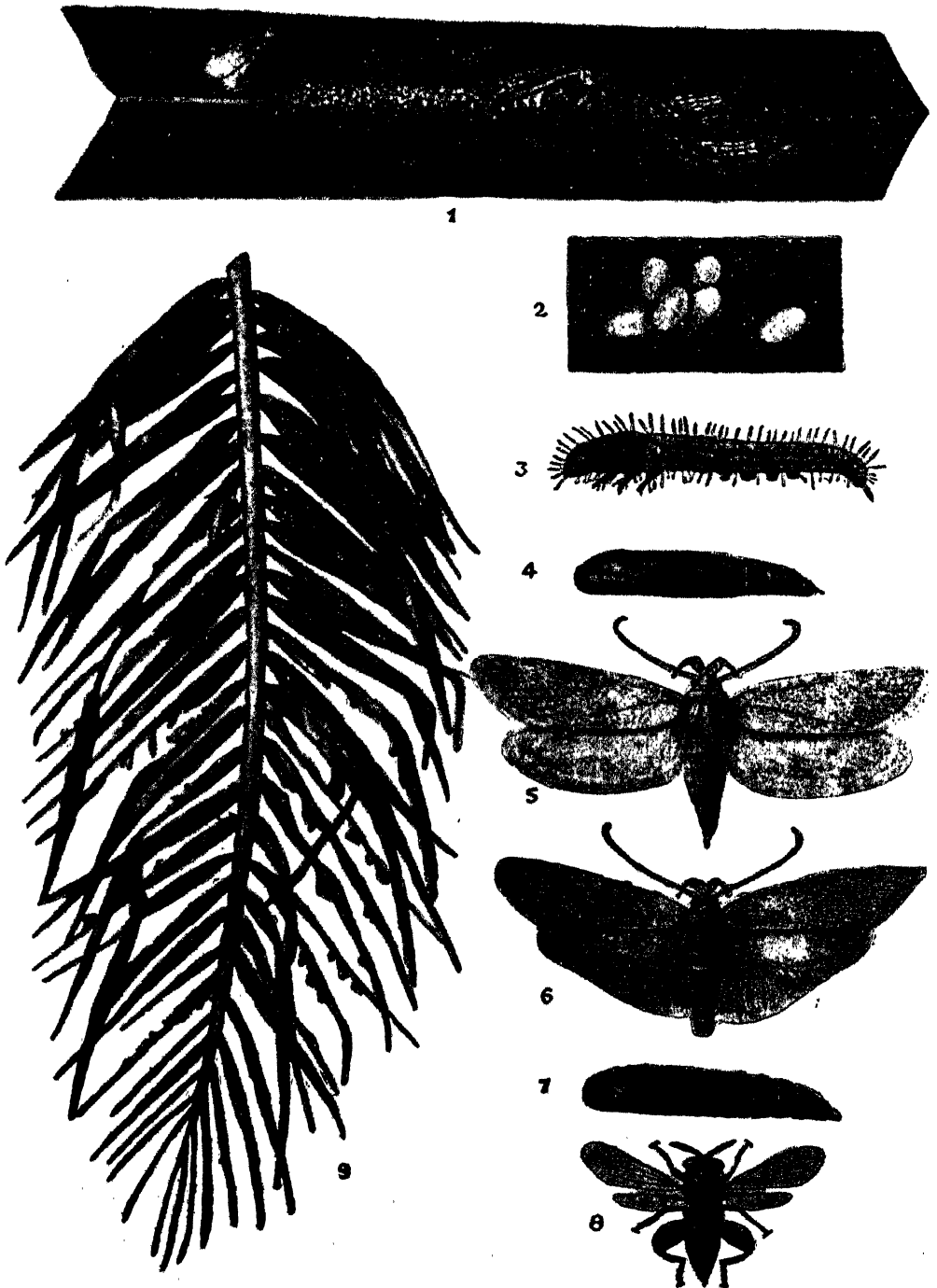
Plate 83, Fig. 2 magnified about 10 times and other figures about 4 times.

The caterpillar (Fig. 3) feeds by nibbling the tissue of the leaves of all kinds of palms and lives on the leaves hiding inside galleries formed over the infested parts by binding together pellets of excreta and dry bits of leaf tissue much like mud galleries formed on walls, etc., by termites (white ants) (Fig. 1). In Burmese the pest is therefore named *Chabyan* or flying termite. The brown galleries covering the infested leaves are easily noticed and indicate the presence of the pest. The nibbled parts dry and gradually decay. As many as a thousand caterpillars occur on a single leaf of coconut or toddy palm. The entire leaves are thus spoilt (Fig. 9). Later on only midribs of the leaflets may be left. The pest has a peculiar habit of infesting the lowermost leaf first and gradually goes to the next higher ones. If left uncontrolled all the leaves in a tree may be affected and spoilt.

When full-grown the caterpillar transforms into a brown pupa (Fig. 4) and the moth (Fig. 5 female and 6 male in flying posture) develops from the pupa and lays eggs (Fig. 2) on the leaves giving birth to the caterpillars. Each life-cycle is completed in about four weeks and each female moth lays about 200 eggs. The pest thus spends its whole life on the leaves and breeds at the same time. Fig. 8 is a parasite which emerges from pupa (Fig. 7) after killing it.

The pest frequently occurs widely over large areas both on coconut and palmyra palms.

The only effective control is to cut off the first affected leaves or affected parts of the leaves in time and burn them. If this is carried



COCONUT LEAF NIBBLING CATERPILLAR (*Nephantis serinopa*)

out systematically by all owners of palms the pest gets no chance to multiply and increase and there is hardly any damage. All palms young and old in the whole locality require to be attended to.

OTHER MINOR PESTS.

Seedling coconut palms may be affected by termites and Ground Red Ants (*Dorylus*, Text Fig. 57) which can be kept off by the use of kerosene emulsion water.

Scale insects may be bad especially on young palms and can be easily controlled by being sprayed with rosin compound solution.

Caterpillars of butterflies (*Udaspes folus*, Text Fig. 65) and the Spotted Grass-hopper (*Aularches miliaris*, Text Fig. 51) occasionally eat leaves but never do appreciable damage.

PESTS IN HOUSES AND STORES.

General Household Pests.

Cockroach.

Text Fig. 5.

For a general description of this insect see page 10. The cockroach is a pest in unclean houses and stores. It lives and breeds in dark unused boxes, cases and drawers as well as in dark corners and crevices in houses. It contaminates food and is also suspected of being agents in transmitting and spreading diseases and should be looked upon as a pest. Its excreta imparts to articles of food a nauseous smell which is not removed even on cooking.

Houses and stores without any dark corners are free from cockroaches. If such places are present they should be dusted, swept and washed with phenyle or crude oil emulsion water occasionally.

In infested houses and stores cockroach paste can be used. (See Recipe No. 10).

Cockroaches can also be trapped in open-mouthed kerosene tins or earthen pots containing fermenting molasses water about one-fourth full. The traps are placed out at night. Cockroaches fall into the water and should be taken out and destroyed in the morning.

BED BUG.

Text Fig. 2.

For a general description of this insect see page 7. In addition to causing annoyance by sucking blood bed bugs are suspected of transmitting some diseases like leprosy, dengue fever, etc., and their bite should be avoided as far as possible. They live and flourish in unclean houses.

Beds, furniture, etc., should be dusted, cleaned, sunned and aired. When once bed bugs get access into a house it is necessary to take some trouble to get rid of them as they live hiding in inaccessible crevices. Creosote oil should be applied into these crevices in order to force them out. Formalin water containing about 10 per cent of commercial formalin ordinarily sold or crude oil emulsion solution at a strength of about $1\frac{1}{2}$ lbs. to a kerosene tin full of water can also be used.

LICE.

The head lice (Text Fig. 1) are very common especially among children and lower classes of the people. This is simply due to want of a little care in cleanliness. The lice have an insidious way of spreading among children in the class rooms and on the play ground. A single lousy child is a source of infection to all the children in a class or boarding house. Adults also infect one another very easily. A single lousy inmate is a source of infection to all others in the house.

As a preventive against lice cleanliness is essential. The head should be regularly washed and combed with close-toothed fine combs. In order to free a lousy head from lice the quickest method is to wash the head and hair copiously with ordinary methylated spirit. All lice are killed. The head and hair should be washed with water after about half an hour and combed. A second washing with spirit may be necessary after a few days as all eggs are not affected by the treatment and young lice hatch out from them. A body louse also occurs but rarely.

ANTS.

It is not necessary to describe how ants cause annoyance in houses attacking all kinds of food and sometimes getting into beds. The surest preventive is to use ant-preventing troughs below the legs of cupboards, almirahs and beds as illustrated in Text Fig. 26. The troughs are kept filled with water to which a few drops of kerosene oil or phenyle are added or a little crude oil emulsion dissolved in order to prevent breeding of mosquitoes. A rag smeared with crude oil emulsion can be wrapped round the legs.

HOUSE FLIES.

Text Fig. 10.

The flies which come into houses are of several kinds which breed in cattle dung, rubbish-heaps, rotten substances and also in human faeces. The life-history is illustrated in Text Fig. 10. Eggs are laid in the stuff on which the maggots feed. The maggots when

full-grown go into the ground and there transform into pupæ (puparia) from which flies develop. The life-cycle of ordinary flies takes only about ten days or so and as each fly lays several hundred eggs it can be easily imagined how fly plagues appear.

Flies visit and sit on all sorts of nasty undesirable and dirty substances and places and carry disease germs on their feet. This is how germs of cholera, typhoid, enteric, tuberculosis, etc., are transmitted to the food of human beings and the diseases spread. All kinds of food and drinks should be protected against flies and it is advisable not to take any food on which flies sit or drink any milk, etc., into which flies have fallen without thoroughly heating and boiling such food and drink again.

MOSQUITOES.

Text Figs. 8 and 9.

There are many kinds of mosquitoes. All breed in water. Even small collections of water in cavities on tree trunks, at bases of leaf sheaths of plantain trees, in broken pieces of tins and earthen pots lying anywhere and in fact all accumulations of water however small are taken advantage of for the purpose.

Mosquitoes cause annoyance by biting and sucking our blood. While biting they transmit disease germs from sick to healthy persons. This is how germs of malaria and several other diseases are spread. All mosquitoes however are not capable of transmitting all diseases. Certain mosquitoes transmit malaria, others transmit yellow fever and so on. Such injurious agency of only a few mosquitoes has been studied and determined. There are many mosquitoes whose habits and injurious capabilities are unknown.

The best plan is to avoid mosquitoes wholly if possible. Sleeping under mosquito nets is essential. In order to kill off wrigglers and not to allow mosquitoes to breed and increase in number no water should be kept in pots for several days together and empty tins, etc., in the neighbourhood should be emptied out frequently. Kerosene or phenyle should be used in water in ant-preventing troughs, etc., in houses. If all accumulations of water are attended to mosquito nuisances in houses can be minimised to a great extent. Doors and windows can be protected with wire gauze. Mosquito coils, the fumes of which keep off mosquitoes should be used by all who can afford to use them when sitting outside in evenings or mosquito oil can be used (Recipe No. 11).

TICKS.

(Fig. 2 Text Fig. 15.)

Ticks are not insects, properly speaking, but are grouped among spiders. They are very common on dogs and cattle and suck their blood. When fully gorged they drop off and lay eggs on the ground. Young ticks crawl on to grasses and attach themselves to passing animals. Animals badly infested by ticks lose condition and suffer in health. Ticks are also known to cause fever.

Ticks require a strong wash to be dislodged. Crude-oil emulsion water at a strength of about a pound in one gallon water can be rubbed on the skin copiously and allowed to remain for about an hour and then the animal can be washed with soap.

Occasional insect nuisances.

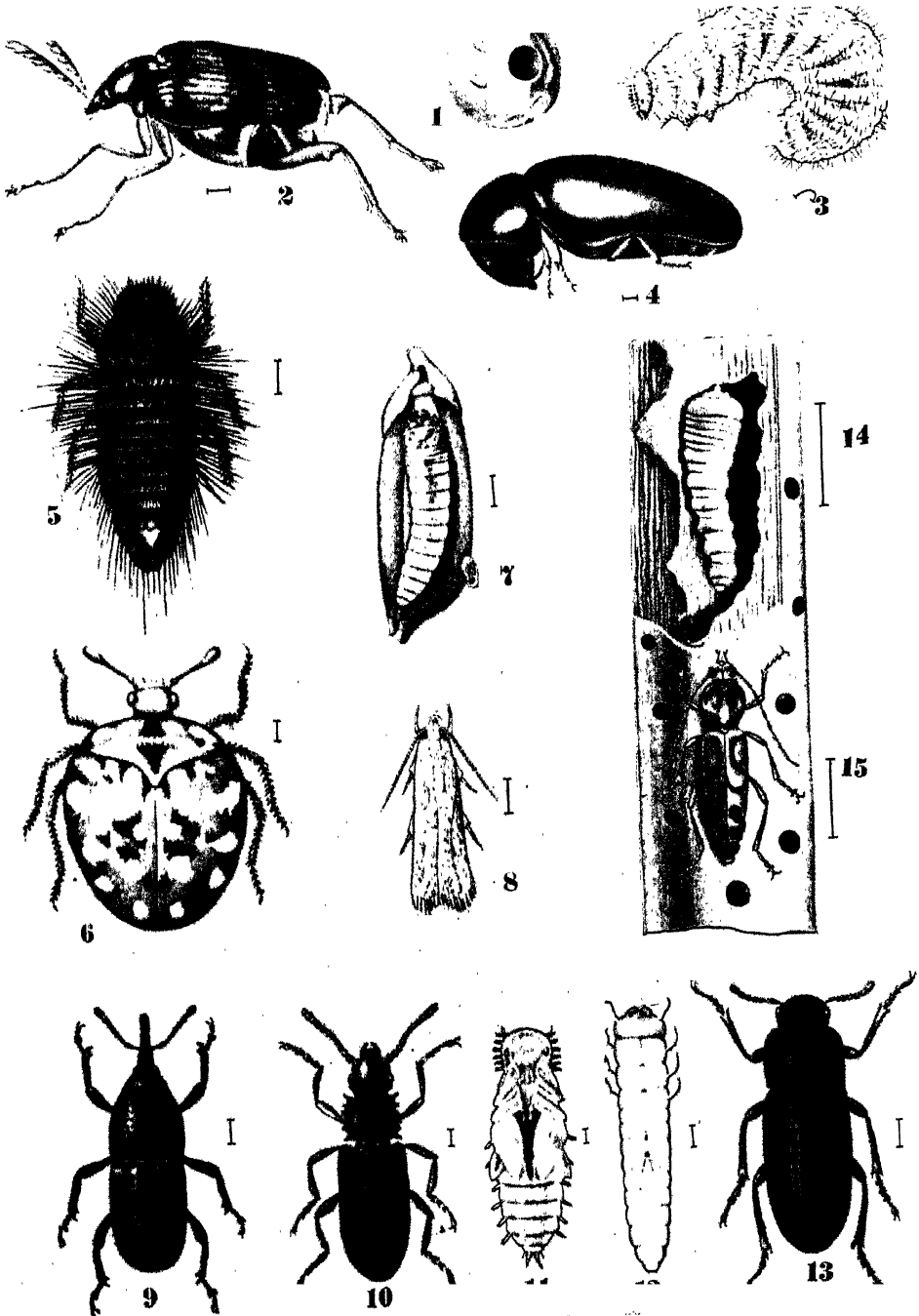
On humid sultry evenings especially during the rainy season many kinds of insect swarm in to lights and cause a lot of annoyance and inconvenience. They include bad smelling bugs, many kinds of beetles some of which cause blisters on the skin, ants, moths, winged termites, wasps, crickets, etc. Swarms of small green Jassid bugs round lights are a nuisance in early winter. These nuisances can hardly be avoided. Sultry evenings can however be easily made out through experience and performance of necessary work in daylight and use of as few lights or no lights in the evenings can mitigate this nuisance. The insects swarm out as soon as darkness sets in. Very few fly after about an hour or so.

On paddy in husk.**THE ANJOUMOIS GRAIN MOTH.****(*Sitotroga cerealella* Oliv.)**

VERNACULAR AND LOCAL NAMES.—*Asi-hpauk-po*, i.e., seed boring insects
Saba-po (Akyab); *Po-hpalan* (Kyaukse).

Plate 84, Figs. 7 and 8.

This may be said to be the only pest on paddy in husk in the store. Eggs are laid among or on the grains lying uncovered and exposed. The tiny caterpillars which hatch from these eggs bore into the grains through the point where the stalk breaks off and eat the rice inside. When full-grown they transform into pupæ there and ultimately issue as moths through holes in the husk provided by the caterpillars before pupation. The small moths are observed flying in the store or over heaps of grains. Holes in grains indicate the presence of the pest. The life-cycle takes about a month, viz., eggs 5 to 6 days, larva 15 days and pupa 7 days. Each female moth lays about 150 eggs.



Household and granary pests

The pest can also breed in wheat, barley and maize and attack these grains in the store. It breeds on these grains in the ears in the field but on a very small scale. It is really a pest in the store and also on grains lying for a long time in heaps in the open.

The pest is not a very rapid breeder and causes damage only when the grains lie for a long time uncovered and exposed so that the moth has free access. The damage is confined to the upper layer but may extend lower down according to the length of time the pest gets to breed undisturbed and varies according as the surface exposed is large or small. It is however never very severe. In large godowns with paddy stored for about three years or more the maximum damage observed has not exceeded about 4 or 5 per cent in the upper layers.

Control depends on whether the moth can be prevented from having access to the grain or not. It is not enough to close the godowns well. The pest can breed if the moths find flying and moving room over the grains. If possible a piece of cloth above the grains with a layer of sand on it affords complete protection. Covering the entire surface with mats also prevents damage to a great extent.

On Rice.

THE RICE WEEVIL.

(*Calandra oryzae*).

Plate 6.

Its life-history is illustrated in Plate 6 and described on page 20. It is a serious pest on wheat and also, though to a less extent, on husked rice, maize, barley and sorghum grains in the store. Very rarely it also occurs on unhusked paddy grains. The damage starts in the layers of grain near the places where the weevils find access. Therefore the upper exposed layer suffers most. In fact the damage is practically confined to this layer and extends downwards according to the time the pest gets to breed. Small lots of grain stored in earthen pots or bamboo or other vessels in houses usually suffer badly, while damage in large heaps or in large godowns may amount only to a small percentage. In the aggregate more damage takes place in the small lots of grain in houses and requires to be guarded against.

The easiest and the most effective protection is to store the grains in vessels without any cracks or holes at the sides or bottom, cover them at the top with a piece of cloth and have a layer one or two inches thick of dry sand on the cloth. It is necessary to see that the grain stored is not already infected. Different grains require different

treatment against this pest. Husked rice may be stored in any vessel if mixed with dry lime sufficient to cover all the grains with a layer of lime. Otherwise it is better stored under sand.

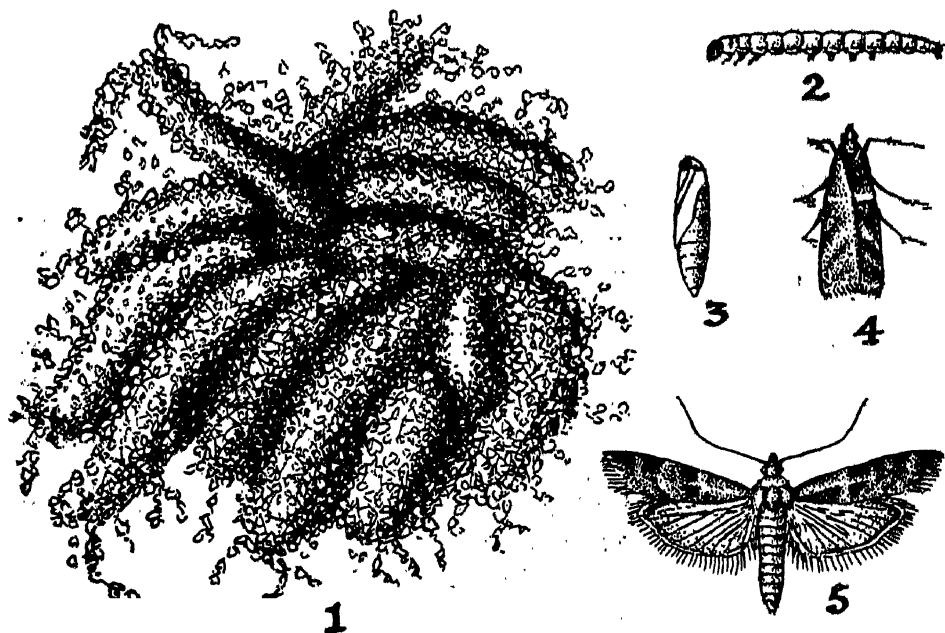
Wheat is most liable to damage. Lime, ashes, etc., affect wheat grains injuriously and should never be used with this grain which is best stored in a thoroughly dry condition under sand. The best plan is to dry the grains in the threshing yards in the hot sun in thin layers so that all the grains get heated. This process can with advantage be repeated for a few days and the grains stored one afternoon in the permanent vessels.

Barley, maize and sorghum grains should also be given the same treatment and stored similarly.

Maize for use as seed is best stored in the cob without removing the sheaths, the cobs being hung up under a roof in an airy place. This is the best method for the local cultivators who require only small quantities of seed.

THE GRAIN BINDING CATERPILLARS.

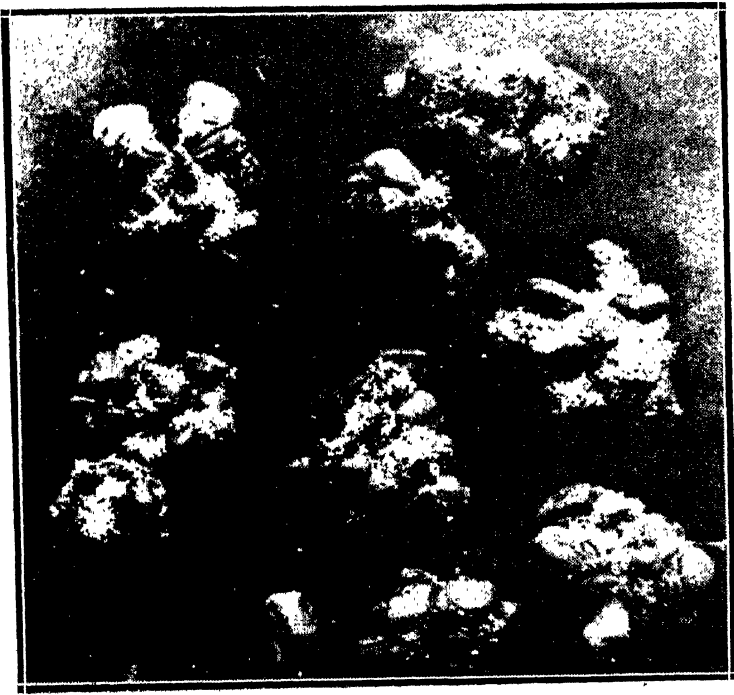
(*Ephestia cautella* Wlk.; *Pyralis farinalis* Lin; *P. pictalis* Curt.; *Corcyra cephalonica* Stn.)



Text Fig. 92.

GRAIN BINDING CATERPILLARS.

- 1 A NUMBER OF SILKEN WEBBINGS, 2. CATERPILLAR, 3. PUPA, 4. MOTHS SITTING, 5. MOTHS FLYING.



Text Fig. 93.

Ephestia CATERPILLARS BINDING *pelun* SEED.

The caterpillars of several moths occur among grains such as wheat, husked rice, etc., and also in ground meal of such grains. They have the habit of binding the grains or particles of the meal and pellets of their own excreta with silk into lumps or chains and living hidden inside and feeding from there. They seldom occur in very large numbers or cause much damage but the lumps and chains easily attract attention and often cause alarm. Frequently enquiries and references are made as to the fitness for human consumption or otherwise of the whole quantity of grain and meal harbouring such caterpillars. The quality of the bulk is hardly affected and it can be used after sieving out the insects with the lumps.

The caterpillars when full-grown turn into pupæ inside the lumps and chains and ultimately issue as moths which lay eggs when they have access to the grain or meal. The grain-binding caterpillars hatch from these eggs.

Wheat flour, etc., should be stored in closed vessels so that moths may not have access to them.

On Wheat.

THE WHEAT HAIRY GRUBS.

(Trogoderma khapra Everts.)

VERNACULAR AND LOCAL NAMES.—*Asi-hpauk-pho*, i.e., seed boring insect.
Gher (Toungoo—Sgaw-Karen).

Plate 85.

These hairy grubs (Figs. 4 to 8 and 17) eat wheat grains, sometimes maize and pulses, in store and when full-grown turn into pupæ (Fig. 12) inside the larval skins which split along the back (Figs. 10 and 11). Beetles (Figs. 13 and 14) develop from the pupæ and lay eggs (Figs. 1 to 3) among the grains. Grubs hatch from these eggs. Breeding is most active in the moist months from about May to August or September, when each generation is completed in about four to five weeks. Damage is confined to the topmost layer of the heap and gradually goes deeper with the time the pest is allowed to breed undisturbed. Although the pest is less common and somewhat less injurious than the Rice Weevil it is one of the major pests of wheat grains in the store.

A layer of dry sand as recommended for the Rice Weevil is an effective protection against this pest.

THE ROUND-HEADED GRAIN BEETLE.

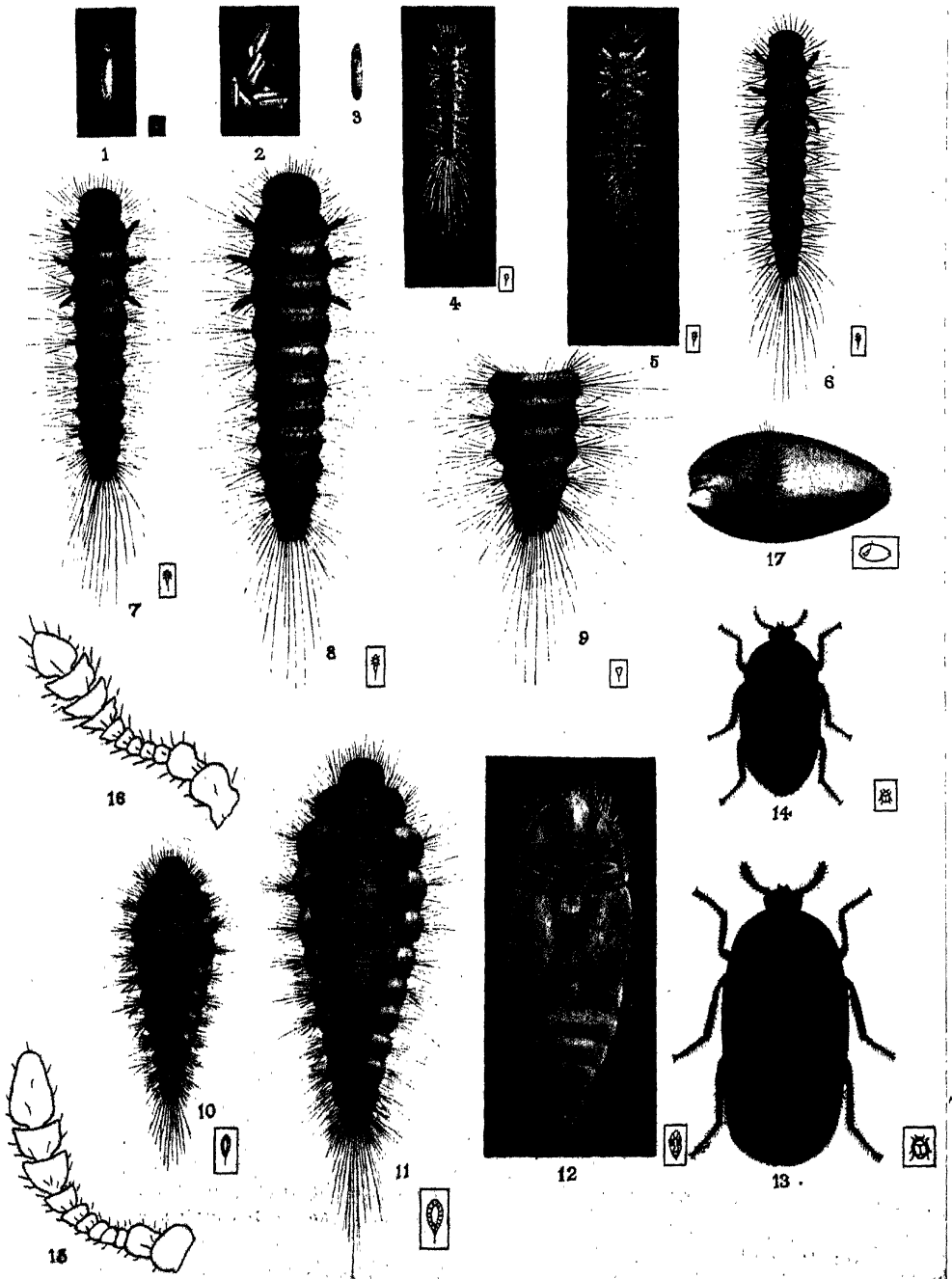
(Rhizopertha dominica Fab.)

VERNACULAR AND LOCAL NAME.—*Asi-hpauk-pho* ; *Gher*
 (Toungoo—Sgaw-Karen).

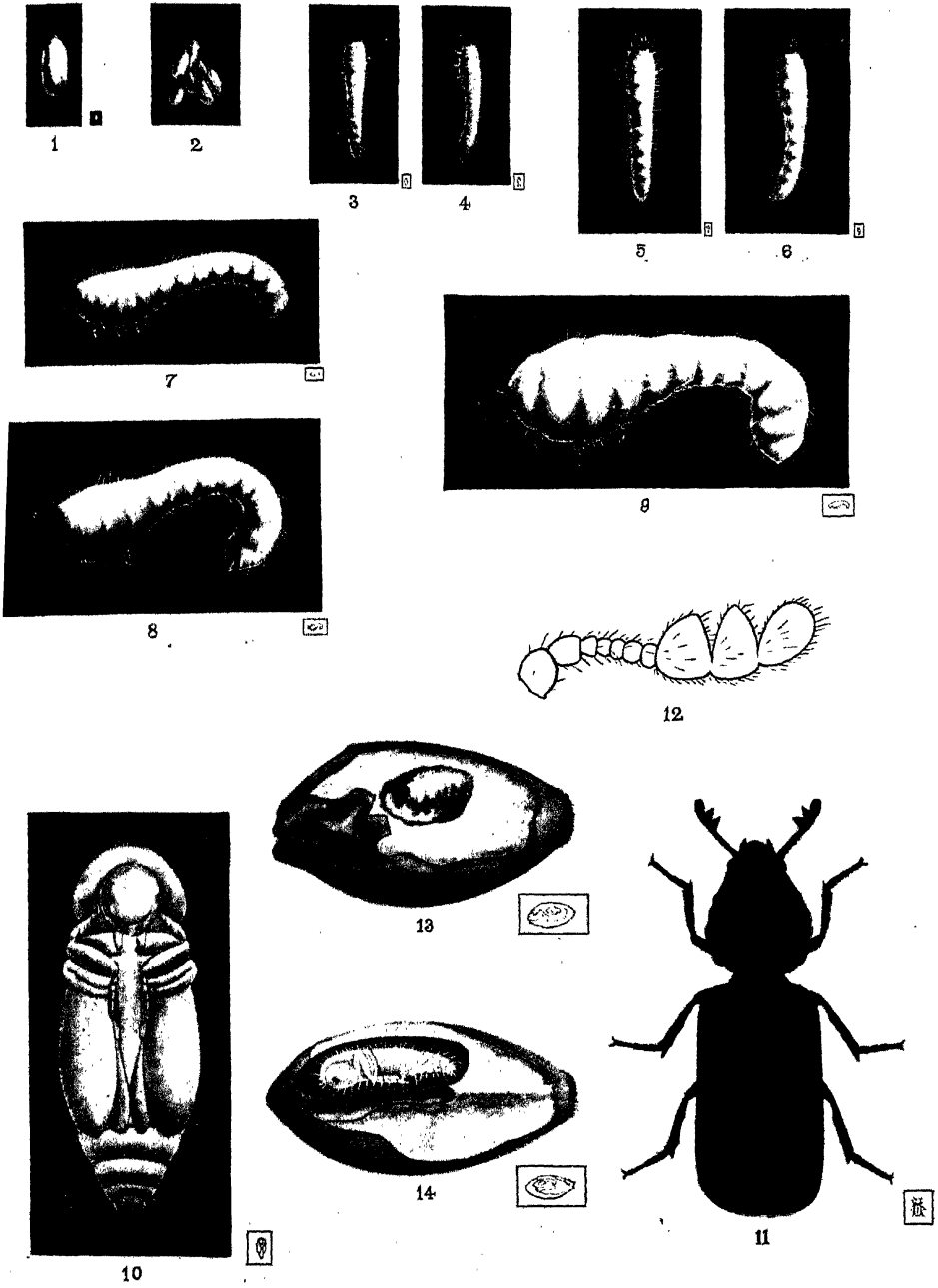
Plate 86.

This round-headed small beetle (Fig. 11) is a serious pest especially on wheat grains in store when the grains are kept in earthen or other vessels and their mouth sealed with earth and cowdung as is frequently done with the hope of preventing insects. This condition is apparently very suitable for the breeding of this insect which may render all the grains useless and in a very short time. This beetle is also known to attack biscuits and is allied to borers in dry wood and bamboo (Text Figs. 100 and 103.) The female beetle gnaws holes in the grains and deposits eggs (Figs. 1 and 2) in these holes. The grubs (Figs 3 to 9) hatching from these eggs feed by corroding inside the grains (Fig. 13) and when fullgrown turn into pupæ there (Figs. 10 and 14) and ultimately issue as beetles. Ordinarily the life-cycle takes 4 to 5 weeks.

This pest cannot prove injurious unless the mouths of the vessels are sealed. The method of storing under sand is an effective protection



Wheat Hairy Grubs
(*Trogoderma khapra*)



Round-headed Grain Beetle
(*Rhizopertha dominica*)

On flour, ground cereals and other meals.**THE FLOUR BEETLE.****(*Triboleum castaneum* Hbst.)****Plate 84, Fig. 13.**

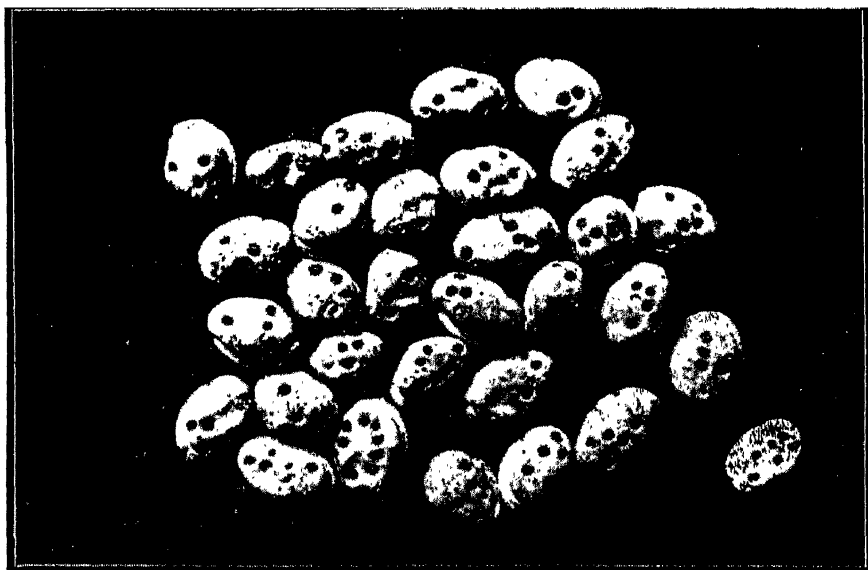
This red-coloured flattened beetle is a serious pest especially of ground wheat (*atta*). It also occurs in the ground meals of other cereals as well as among whole grains but is seldom as injurious in whole grains as in ground wheat. In fact in sound grains it occurs in company with the other pests which corrode grains and produce dust on which it can feed. The beetle lays eggs among *atta* and the grubs hatch from these eggs and are like Fig. 12 in the plate but brown in colour and feed on the *atta*. The slender grubs covered with particles of *atta* are easily observed moving about in the infested flour. When full-grown they transform into pupæ in the infested material and ultimately issue as beetles. The beetle therefore passes its whole life among the infested *atta*. Fresh generations occur about every month. Humid conditions in the rainy season help breeding on a large scale and the pest causes serious damage from about July to November. During this time dust is thrown out from all over the surface of gunny bags containing *atta* mainly due to the movements of the grubs which breed inside. Apart from damage due to the feeding of the beetles and their grubs, the infested material acquires a nauseous smell and taste and becomes practically unfit for human consumption for this reason.

It is impossible to prevent infestation of *atta* stored in gunny bags. The best method is not to store *atta* for long periods and to prepare and use it as necessary, otherwise it has to be stored in tins or other closed vessels which can prevent access of the beetle wholly. Even when stored properly in this manner storing should be carried out immediately after preparation. If storing is delayed or the *atta* transported over some distance in bags and the beetles have a chance of access the best plan is to pass the stuff once again through sieves in order to eliminate beetles if any and then to heat the stuff sufficiently in order to kill off eggs which may have been laid and carry out storing immediately after heating.

On Pulse and Bean Seeds.

THE PULSE BEETLES.

VERNACULAR AND LOCAL NAME.—*Asi-hpauk-po*, i.e., seed boring insect ;
Gher (Toungoo—Sgaw-Karen.)



Text Fig. 94.

BRUCHIDS DAMAGING PEGYI SEEDS IN STORES.

(*Bruchus phaseoli*.)

Almost all beans belonging to the botanical species, *Phaseolus lunatus*, are practically immune. These include the Rangoon Red Bean (*pegya*), Rangoon small white bean (*pebyugale*) and butter beans (*htawbatpe*). They remain free if properly dried at harvesting time and occasionally dried and cleaned while in the store. Even if a few pulse beetles occur no appreciable damage is done.

The Indian bean (*pegyi*) and its varieties, *maung-ma-khaw-pe*, *shwe-yimma*, etc., are badly damaged by the *phaseoli* pulse beetle (Text Fig. 46). The beetles continue to breed in the dry seeds in the store. Eggs are laid on the seeds and look like white specks (Text Fig. 94). Grubs hatching from the eggs bore directly into the seeds and feed, grow and pupate in them, the resultant beetles issuing through fresh holes. As several grubs feed and develop in a single seed each seed may have many holes. The beetle may cause serious damage unless

control measures are adopted. As the beetle finds its way into the store with the seeds which are already infected in the field, it is necessary to eliminate the infested seeds at the harvesting time before storage. The seeds should be steeped in water for about two hours. Infected seeds swell and can be picked out. Infected and uninfected seeds can thus be separated and thoroughly dried before storage. Drying is best done by being spread out thinly in the hot sun for several days so as to heat all the seeds. Most of the young grubs inside the seeds are thus killed. Steeping does not kill the grub feeding inside the infected seeds which should therefore be used up as quickly as possible. The uninfected seeds should be stored in closed vessels with a layer of dry sand on top or in closely woven good gunny bags, thus preventing access of any beetle from outside. If the seeds are left exposed they may get infected at any time.

Pigeon peas (*Cajanus cajan*—~~pesinngon~~) are liable to be damaged by the *chinensis* pulse beetle (Plate 84, Figs. 1 and 2) which breeds both in the field and in the store practically in the same way as the *phaseoli* pulse beetle. This beetle is a serious pest on pigeon peas especially and on cowpeas (*Vigna catjang*) and may also attack in the store other pulse seeds such as grams and peas. In the case of all seeds the method of heating them in the sun should be followed at harvesting time. This is especially effective in the case of small seeds. On account of their small size, pigeon peas and cowpeas which are already infected in the field are not easily separable by steeping in water like the large white beans. Some varieties of pigeon peas, for instance some white-seeded ones, suffer less than some red-seeded ones. This comparative immunity has yet to be studied and found out. It is advisable to grow those which are less liable to attack. The best form of storage is under layers of dry sand or even in sand. Beetles which emerge from the infected seeds come to the surface of the sand and cannot get at the sound seeds, so that further damage is stopped. Sand no doubt gets into the holes of bored seeds but is easily washed off when the seeds are split and *dal* prepared from them.

Cowpeas are infested in the field as well as in the store by the *chinensis* (Plate 84, Figs. 1 and 2) and *analisis* (Text Fig. 47) pulse beetles. The *analisis* beetle is however less injurious than both *phaseoli* and *chinensis* beetles for the reason that although many eggs may be laid on a seed only one grub develops in a seed. The *analisis* beetle also continues to breed in the store on dry seeds in the same way as the *phaseoli* and *chinensis* beetles. As regards storage the same remarks are applicable as for pigeon peas.

The black and green grams (*Phaseolus mungo* and *P. mungo aureus*) are usually infested in the field by the *analisis* pulse beetle but

in the store are liable to be attacked by *chinensis* as well. As regards harvesting and storage the same remarks are applicable as for pigeon peas and cowpeas.

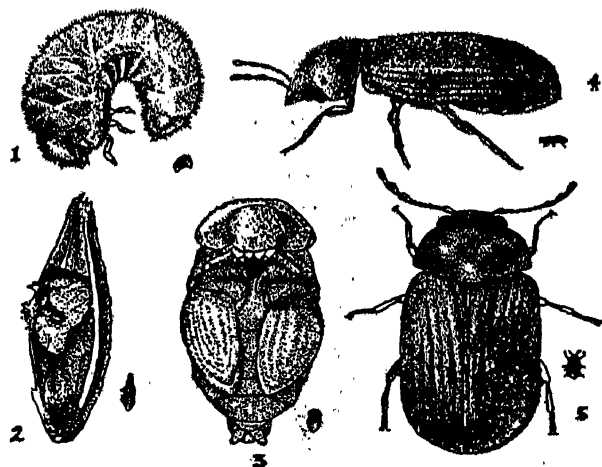
ON DATES, RAISINS, Etc.

A small red beetle (Plate 84, Figs. 10 to 12) occurs on these sweet fruits in the store. Both the beetle and its grub frequently feed just under the skin of the dates and the skin peels off. They also bore in the pulp of the fruits. When full-grown the grubs transform into pupae (Fig. 11) in the fruits. Beetles develop from the pupae and lay eggs from which grubs hatch. It is not easy to prevent infestation unless the fruits are stored in insect proof vessels. Infestation usually takes place before the fruits are imported into this province. Cleaning and proper storage are necessary by the users as soon as the fruits come into their hands.

This beetle infests raisins also in store.

ON SPICES IN STORE.

On turmeric, dry ginger, dry chillies and dry long pepper, the Cheroot Beetle (Plate 87 and Plate 84, Figs. 3 and 4) occasionally occurs but hardly causes serious damage.



Text Fig. 95.

BEETLE (*Anobium* SP.) IN CUMIN SEED IN STORE (AFTER FLETCHER AND GHOSH).

1—2. GRUB, 3. PUPA, 4—5. BEETLE.

Aniseed, cumin seed, ajwain (*Samok*, *Carum Copticum*), ajmud (*Tayok nannan*—*Apium graveolens*) and coriander seed are likely to be infested by a small beetle (*Anobium* sp.—Text Fig. 95). The grubs

bore the seeds and pupate in a small cocoon in the bored seeds and ultimately emerge as beetles which lay eggs giving rise to the grubs. No serious damage is however caused.

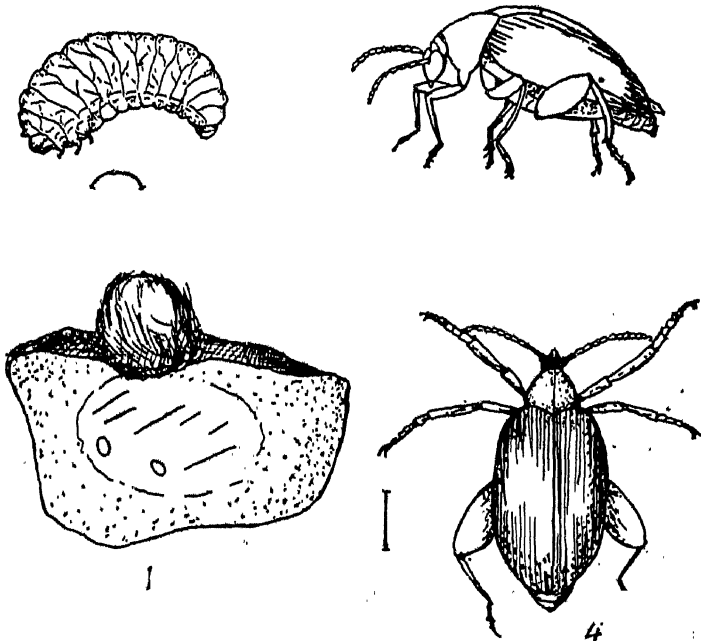
Occasional cleaning and drying keep off the pests entirely.

ON TAMARIND IN STORE.

One bruchid beetle and one weevil breed in tamarind seeds in the store. The practice is to store the tamarind with as well as without the seeds. In the latter method no infestation takes place.

THE TAMARIND SEED BRUCHID.

(*Caryoborus gonagra* F.)



Text Fig. 96.

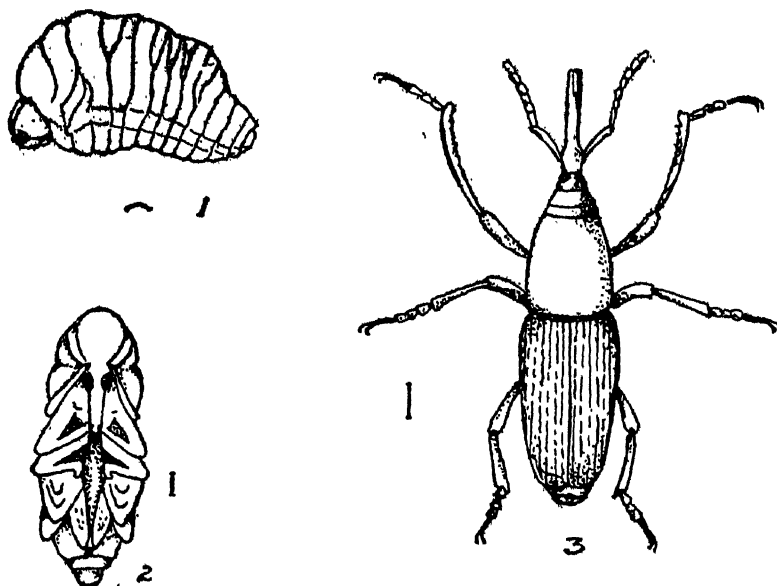
TAMARIND SEED BORER BEETLE. (*Caryoborus gonagra*.)

1. TAMARIND SEED WITH TWO EGGS AND COCOON PROTRUDING OUT, 2. GRUB,
3-4. BEETLE.

This beetle is allied to the pulse beetles and breeds on the seeds in the same way. The grub, however, when full-grown and ready to pupate prepares a papery cocoon partly protruding out of the infested seed.

It is not a serious pest and hardly any control measures are necessary.

THE TAMARIND SEED WEEVIL.

(Calandra linearis Hbst.)

Text Fig. 97.

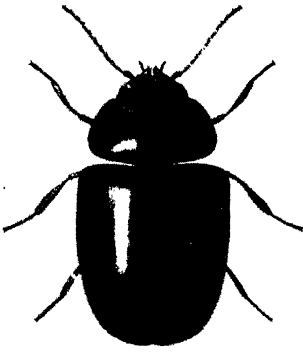
TAMARIND SEED BORER WEEVIL. (*Calandra linearis*.)¹

1. GRUB, 2. PUPA, 3. WEEVIL.

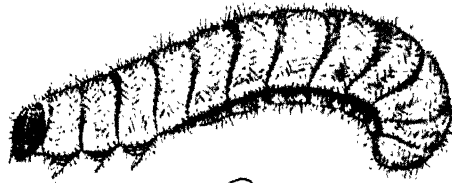
This weevil is allied to but much larger than the Rice Weevil (*Calandra oryzae*). It breeds extensively on tamarind stored with seeds, many grubs occurring in individual seeds which are reduced to shells and dust. Entire unshelled fruits or tamarind stored without seeds are not affected. The dust produced by the feeding of the grubs affects the pulp. The grubs when full-grown transform into pupæ inside the bored seeds and ultimately issue as weevils which lay eggs in the seeds giving rise to the grubs. Ordinarily the life-cycle is completed in about a month.

The seed should be separated from the ripe fruits before storage.

Tamarind is fed to elephants and enquiries are often made as to whether fruits infested by this weevil may cause harm to the animals. No ill effect has however been reported and there is likely to be none.



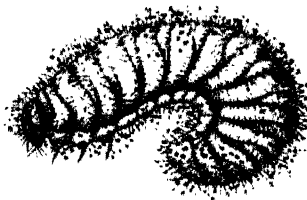
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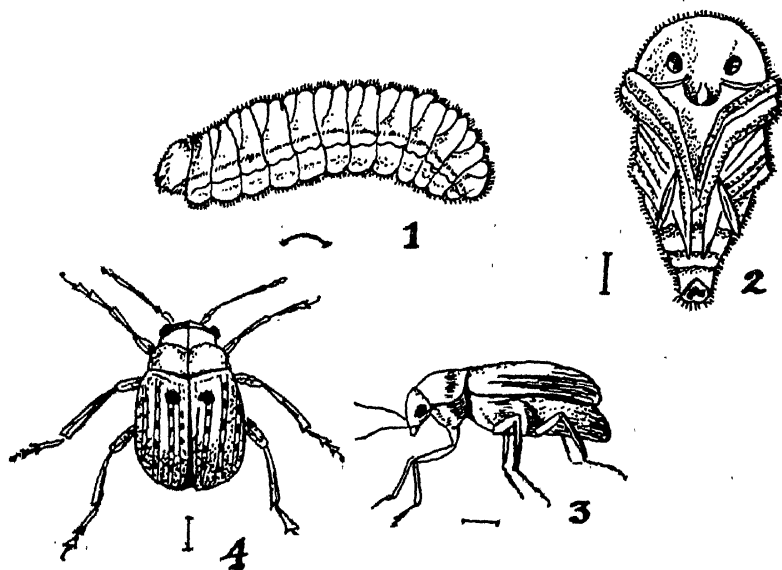
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4

Cheroot Beetle
(*Lasioderma serricorne*)

On Betel Nuts in Store.
THE BETEL NUT BORER BEETLE.
(Aræcerus fasciculatus De G.)



Text Fig. 98.

BETEL-NUT BEETLE.

1. GRUB, 2. PUPA, 3-4. BEETLE.

The grub of this beetle bores the nuts (seeds) in the store and is found in the core when the seed is split open. When full-grown it transforms into a pupa and later issues as a beetle which lays eggs from which grubs hatch.

The grubs seldom occur in injurious numbers and are not vigorous borers. No remedial measures are necessary.

The beetle is also known to occur on dry coffee berries, dry chillies and some bean seeds but not in injurious numbers in any of them.

On Tobacco in Store.
THE CHEROOT BEETLE.
(Lasioderma serricorne Fb.)

VERNACULAR AND LOCAL NAME.—*Hse-po* (Thayetmyo.)

Plate 87.

A red beetle (Figs. 5 and 6 and Plate 84, Fig. 4) breeds in cheroots in the store producing holes in them (Fig. 7) and rendering them useless. It may also breed in the dry tobacco. The beetle lays eggs (Fig. 1) from

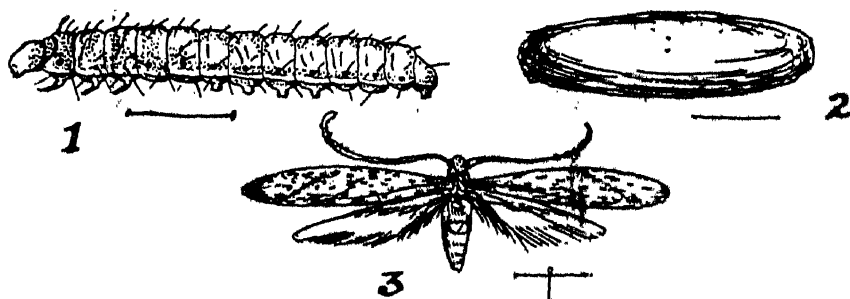
which grubs (Figs. 2 to 3 and Plate 84, Fig. 3) hatch and feed by boring the cheroots and when full-grown transform into pupæ (Fig. 4) from which beetles develop. This pest may cause serious damage. The life-cycle takes about four to nine weeks, *viz.*, eggs 7 to 12 days, grub 15 to 40 days and pupa about 8 to 10 days.

Cleanliness in all places through which the tobacco passes is the surest preventive. The godowns and storage places of the dealers of unmanufactured tobacco, of cheroot manufacturers and also of cheroot dealers should be clean. Old rejected and useless leaves or tobacco dust should not be allowed to lie about and are best burnt. If proper care is taken in this respect cheroots are seldom affected.

Manufactured cheroots may be fumigated with carbon bisulphide. Fumigation (Page 41) kills insects which may be present but does not render the fumigated material proof against attack in future. Storage in insect proof cases is therefore necessary after fumigation.

THE DRY TOBACCO CATERPILLAR.

(*Setomorpha tlineoides* Wals.)



Text Fig. 99.

DRY TOBACCO CATERPILLAR. (*Setomorpha*.)

1. CATERPILLAR, 2. COCOON, 3. MOTH.

The caterpillar feeds by boring through the layers of dry unmanufactured tobacco in store and when full-grown prepares a white elongated oval stiff papery cocoon inside which it transforms into a pupa and ultimately emerges as a moth. Eggs are laid by the moth and give rise to caterpillars.

Cleanliness of godowns and storage receptacles should be attended to. No old tobacco or tobacco dust should be allowed to lie about. In case of attack fumigation with carbon bisulphide can be resorted to. If fumigation is not possible all the layers of tobacco should be turned over and the caterpillars and cocoons picked out and destroyed. Fumigation does not immunise the treated leaf against future attack.

Therefore care should be taken to store the tobacco so that moths may not have access to it.

ON DRY FISH.

A beetle (*Dermestes frischii* Kng) allied to the wheat [hairy grubs (Plate 85) and the carpet beetle (Plate 84, Fig. 6) breeds in dry fish in store, both the beetle and its grubs boring and feeding on the fish.

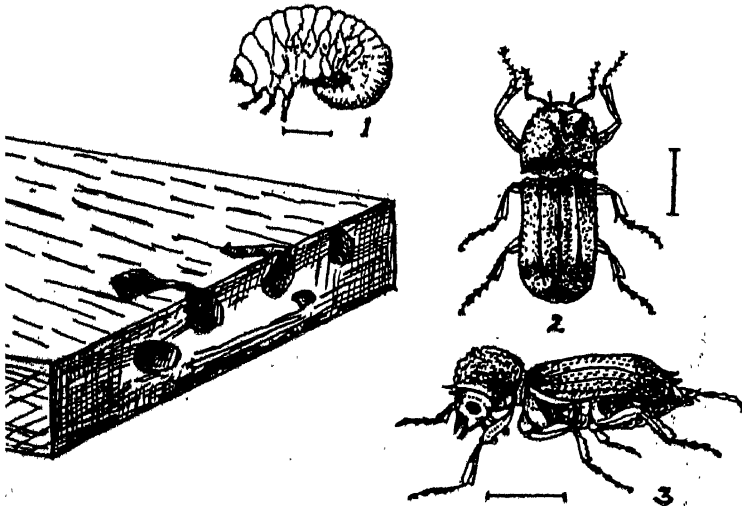
Unless stored in proper receptacles it is not possible to prevent infection. When however the pest occurs in such numbers that it is desirable to free the stuff of the pest this can be easily done by fumigating the fish with carbon bisulphide.

ON WOOD AND FURNITURE.

Some kinds of wood and wooden furniture in houses such as teak, *pyingado* (*Shorea robusta*), etc., are naturally immune and do not suffer from any insect. It is the hard wood which possesses this immunity. Other kinds of wood, such as deal suffer badly. Insects attacking wood are mainly termites and borers.

ROUND HEADED BEETLE BORERS.

(*Heterobostrychus æqualis* Wat.)



Text Fig. 100.

BORERS OF DRY WOOD.

(*Heterobostrychus æqualis*.) (AFTER I.M.N.)

This and allied borers produce many holes in the infested wood like small shot-holes. The beetles first of all gnaw holes and lay eggs in them and the grubs hatching from them, bore in all directions. Both the grubs and beetles throw out dust. The grubs when full-grown transform into pupæ in the tunnels and emerge as beetles which continue to breed in the wood. As a result the wood is severely damaged being reduced to shell and dust.

LONGICORN BEETLE BORERS.

(*Stromatium barbatum* Fab.)



Text Fig. 101.

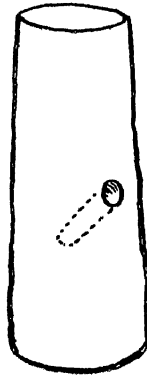
LONGICORN BORERS OF FURNITURE.

(*Stromatium barbatum*.)

This is allied to the mango stem borer described on page 167 and the life-history is similar but a generation takes about three to four years. The grubs bore picture frames, chairs, tables and other furniture and its presence is frequently indicated by a grating sound due to its biting the wood with its jaws. The grub is long-lived and may feed for three to four years before transforming into a pupa and emerging as a beetle. Each female beetle lays about 150 eggs and eggs hatch in about a week.

The best preventive of damage to wood by termites and borers is to paint the wood copiously with crude creosote oil or better soak it in hot oil. If this is repeated about once a year damage can be prevented almost entirely. Coal tar although effective for a time does not afford sufficient protection and tarred portions are frequently eaten inside. Posts which are buried under ground can be protected by impregnating them with crude creosote oil. This is effected by boring a slanting

hole with an auger and occasionally filling this hole with crude creosote oil (Text Fig. 102).



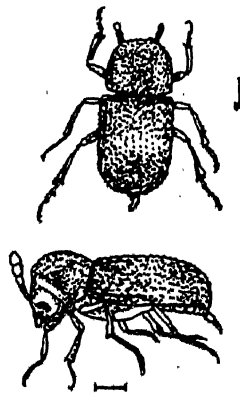
Text Fig. 102.

TREATING A POST AGAINST TERMITES.

ON BAMBOOS AND BAMBOO FURNITURE.

Bamboos, bamboo mats used in walls and roofs and furniture made from bamboo suffer from termites and borers. Certain kinds of bamboo fuffer less than others and it is commonly believed that bamboos cut in particular seasons are more or less immune. These points require study.

ROUND HEADED BEETLE BORERS.



Text Fig. 103.

ROUND-HEADED BEETLE BORERS IN DRY BAMBOO.

(*Dinoderus* SP.) (AFTER I.M.N.)

These borers are allied to those in wood (Text Fig. 100) and attack both whole bamboos and bamboo strips used for mats, furniture and roofs. Bamboos which are well seasoned with long steeping under water suffer less than unseasoned ones. Also bamboos cut in particular months known to the local people suffer less. These immunities are apparently connected with rise or fall of sap or washing out of certain ingredients.

Painting mats, etc., with crude earth oil or kerosene oil affords protection for a time. Painting with crude creosote oil immunises them, especially split bamboo for long periods. The effect lasts several years.

LONGICORN BEETLE BORER.

(*Chlorophorus annularis* Fairm.)

Plate 84, Figs. 14 and 15.

This longicorn borer grub (Fig. 14) bores usually whole dry bamboos. When full-grown it transforms into a pupa in its own tunnel and ultimately emerges as a beetle (Fig. 15) which lays eggs giving birth to grubs.

The same measures should be adopted as against the shot-hole borers above.

Against termites painting crude creosote oil is an efficacious measure.

On Furs and Woollen Goods.

WOOLLY BEAR OR CARPET BEETLE.

(*Anthrenus vorax* Wat.)

Plate 84, Figs. 5 and 6.

The black hairy grubs (Fig. 5) of this beetle (Fig. 6) are serious pests of all kinds of hair and fur which they cut off and on which they feed. Brushes, saddles and cushions in which animal hair is used suffer. When full-grown the grubs transform into pupæ inside the larval skins which split along the back (see Plate 85, Figs. 10 and 11). Beetles (Fig. 6) develop from the pupæ and are very active and easily find access to places where such goods are stored. They lay many eggs from which grubs hatch and feed voraciously. Very serious damage is caused in a short time. The life-cycle takes about two and a half to three months, *viz.*, egg about 9 days, larva about 50 to 60 days and pupa 15 days. This is in ordinary weather but the life-cycle may extend to about nine or ten months if cold weather intervenes.

Ordinary cupboards and boxes which are opened even occasionally afford no protection against the pest. All furs should be stored separately from other clothing and in practically airtight boxes with

plenty of naphthalene so that the boxes may be suffused with its fumes. Furs used and dusted daily are not likely to suffer.

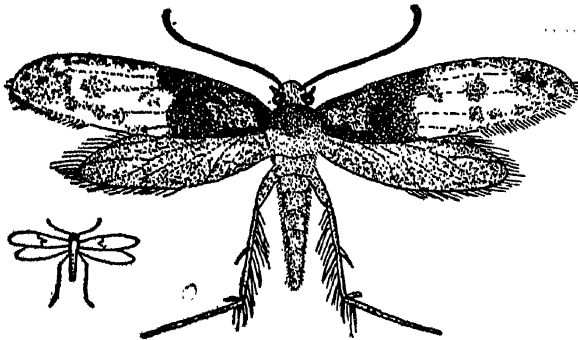
THE FUR MOTH.

(*Trichophaga tapetzella* L.)

Text Fig. 104.

The caterpillars of this moth affect furs practically in the same way as the grubs of the Woolly Bear Beetle and may cause serious damage. They form cases with the cut fur and pupate in these and ultimately issue as moths which lay eggs and the caterpillars hatch from these eggs.

The same protective measures are necessary as against the Woolly Bear Beetle.



Text Fig. 104.

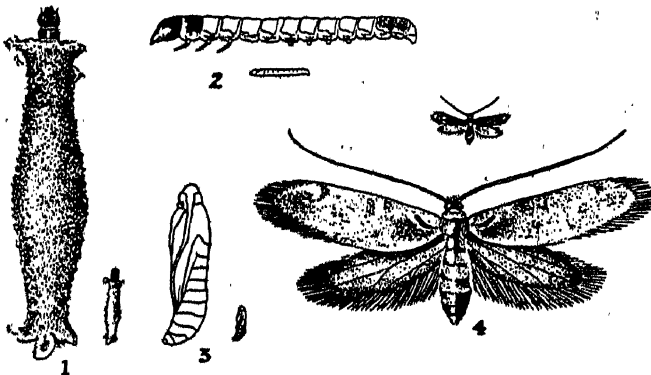
THE FUR MOTH.

(*Trichophaga tapetzella*) (AFTER FLETCHER.)

THE CLOTHES MOTH.

(*Tinea pellionella* L.)

VERNACULAR AND LOCAL NAME.—*Hpra* (Leiktho—*Gebba-Karen*.)



Text Fig. 105.

CLOTHES MOTH (*Tinea pellionella*.)

1. CATERPILLAR IN CASE, 2. CATERPILLAR, 3. PUPA, 4. MOTH. (AFTER FLETCHER)

The caterpillars of this moth are pests of all woollen goods and blankets. They cut the fibres from woven goods or wool, feed on them and also bind them into cases inside which they live. Woollen strands are thus cut into bits and holes are formed in the woven cloth. When full-grown the caterpillars transform into pupæ inside the cases and ultimately issue as moths. Eggs laid by the moth give rise to the caterpillars.

Cleanliness in places where blankets are manufactured is essential. No unnecessary stuff or woollen dust should be allowed to lie about. They help the pest to breed. They can be buried or burnt. Wool and woollen clothes should be stored in places and receptacles where the moth cannot find access. The pest can be kept off wholly if all woollen stuff is stored with naphthalene.

On books and papers.

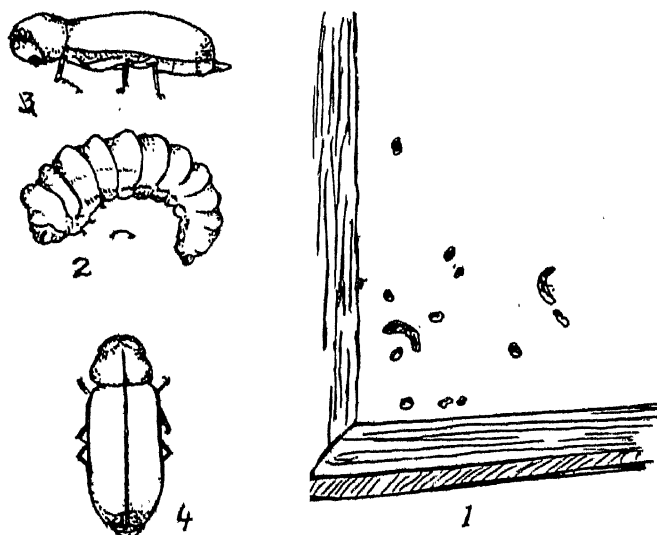
THE SILVER FISH.

Plate 2.

The silver fish nibbles pictures, paper labels, books, etc. Its general life-history is given at page 9.

Stiff paper should be pasted behind picture frames so that silver fish may not find access to the picture. There should also be no gap between the frame and the glass allowing access to the insect. Labels on bottles, etc., should be given a coating of melted paraffin wax or occasionally painted with book solution. The insect finds a good breeding place among loose papers heaped up and in loosely bound books which are not disturbed for long periods. Unless these can be stored with naphthalene in boxes and almirahs which will hold the naphthalene fumes they should be frequently turned over and cleaned and silver fish if found should be destroyed.

THE BOOK BEETLE.

(Gastrallus laticollis. Pic.)

Text Fig. 106.

BOOK BEETLE. (*Gastrallus laticollis*.)

1. BOOK BORED 2. GRUB, 3-4. BEETLE.

The grub of this beetle is a serious pest and bores holes from one side to the other of books. Some kinds of boards and leathers used in the covers seem to be specially liked and are simply riddled with holes, the book also suffering as a consequence.

The life-history is similar to that of Cheroot Beetle (Plate 87). When fully grown the grub transforms into a pupa in its tunnel and ultimately issues as a beetle which too feeds by boring through the books and depositing eggs in the holes thus gnawed. Grubs hatch from these eggs and damage books as described above. The books in an almirah hardly give any indication of attack and damage until they are opened. Therefore the books may be destroyed before the presence of the pest can be detected.

Books should be stored in almirahs and cases which are fairly airtight so as to hold the fumes of naphthalene which should be liberally used either as flakes or balls. If this is attended to books will remain safe from insect damage. Still they are best taken out, dusted and painted with book solution (Recipe No. 12) once a year.

The solution is painted both on the outside as well as inside of each cover and on the page facing each cover and the book kept for some time standing on its edges and slightly open so as to allow the solution to dry.

COCKROACHES.

Text Fig. 5.

These nibble at night the covers of books lying outside. Books bound with paper or cloth frequently suffer badly. Painting with book solution keeps off cockroaches.

GLOSSARY OF BURMESE WORDS.

Ayet-le-zai-pe	...	A type of cowpea.
Aywet ...	...	Leaf.
Bauk-hpat ...	...	Caterpillar (larva.)
Chin-boung ...	...	<i>Hibiscus canabinus</i> Linn. leaves and fruits are used as vegetable and salads and the fibre is used for making ropes.
Dunghaw ...	...	A variety of bean, <i>Dolichos</i> sp.
Hnan ...	...	<i>Sesamum orientale</i> Linn.
Htawhatpe ...	...	Butter beans, introduced varieties of <i>Phaseolus lunatus</i> Linn.
Kaing ...	...	Elephant grass. Kaing crops are those grown on submerged lands when the water subsides.
Kalabe ...	...	Gram— <i>Cicer arietinum</i> Linn.
Kaukkyi ...	...	Winter rice grown between about July and January.
Kauklat ...	...	Autumn rice grown between July and November.
Kaukti ...	}	Varieties of hot weather rice grown under canal irrigation between about March and August.
Kaukyin ...		
Kazin ...	...	Field embankment.
Kazun-u ...	...	Sweet potato.
Kyan ...	...	Sugarcane.
Kyethun ...	...	Onion.
Leik-pya ...	...	Butterfly ; moth.
Matpe ...	...	<i>Phaseolus mungo</i> Linn.—green gram.
Maungma-khaw-pe	...	A variety of the Indian bean, <i>Dolichos lablab</i> Linn.
Myauk-u ...	...	Sweet potato (Tavoy).
Nadawpe ...	...	A variety of cowpea.
Ngapi ...	...	Fish paste used as condiment.
Oo ...	...	Egg.
Ohn ...	...	Coconut.
Pe-bizat ...	...	Horse gram, <i>Dolichos biflorus</i> Linn.
Pebyugale ...	...	Rangoon small white bean, <i>Phaseolus lunatus</i> Linn.
Pechinbaung	...	Chickling vetch, <i>Lathyrus sativus</i> Linn.
Pe-di-sein ...	...	Black gram, <i>Phaseolus aureus</i> Roxb.
Pedaungshe	...	A type of cowpea.
Pegadiba ...	...	Variety of Rangoon Red bean, <i>Phaseolus lunatus</i> Linn.

Pegya	...	...	Rangoon red bean, <i>Phaseolus lunatus</i> Linn.
Pegyaung	...	...	A type of cowpea.
Pegyi	...	...	Rangoon large white bean, <i>Dolichos lablab</i> Linn.
Pe-lon	...	...	Cowpea.
Pe-myt	...	...	Kaffir bean, <i>Psophocarpus tetragonolobus</i> D.C.
Pe-nauk	...	...	Variety of green gram.
Pe-ngapi	...	...	Soy bean.
Pe-seikgyo	...	...	Variety of bean, <i>Dolichos lablab</i> Linn.
Pe-seinsa	...	...	Chinese yam, <i>Pachyrhizus erosus</i> (Linn.) Urb.
Pe-taingtaung	...	...	A type of cowpea.
Pe-sin-ngon	...	...	Pigeon pea, <i>Cajanus cajan</i> (Linn.) Millsp.
Pe-weeli	...	...	Cluster beans, <i>Cyamopsis psoralioides</i> D.C.
Pe-yaza	...	...	Lentil.
Po	...	...	Insect generally ; specifically silk worm.
Po-ain	...	...	Cocoon.
Po-di-gaung	...	...	Chafer or white grubs.
Po-gaung	...	...	Silk worm.
Po-hpalan	...	...	Moth.
Po-kyaingaug	...	...	Bettle.
Posa	...	...	Mulberry.
Po-ton-lon	...	...	Pupa.
Pyaung	...	...	Sorghum millets.
Saba	...	...	Rice plant.
Sadawpe	...	...	Pea.
Samok	...	...	<i>Ajwain</i> , <i>Carom copticum</i> Linn
San	...	...	Husked rice.
Shwe-yin-ma	...	...	Variety of bean, <i>Dolichos lablab</i> Linn.
Tayok nan-nan	...	...	<i>Ajmad</i> , <i>Apium graveolens</i> Linn.
Tazaungmon-pe	...	...	A type of cowpea.
Thanat-pin	...	...	<i>Cordia myxa</i> Linn.
Thonla-pe	...	...	A type of cowpea.
Thayet	...	...	Mango.
Wa	...	...	Cotton.
Wagyi	...	... } Indigenous cottons.	
Wagale	...		
Yar-pe	...	...	A type of cowpea.
Yonbadi	...	...	Lady's finger.

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